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ABSTRACT

This learning module is designed to integrate environmental education into ninth- and tenth-grade chemistry classes. This module and a companion social studies module were pilot tested in Gwinnett County, Georgia in 1975-76. The module is divided into four parts. Part one provides a broad overview of unit content and proposes questions to stimulate student interest in environmental problems. Part two is intended to develop an understanding of population dynamics. Part three deals with population and land use. Part four addresses the problems of waste disposal. The module is intended to take 16 or 17 days to complete. Some of the activities included are a population study using microbes, a study of symbiosis, soil moisture and percolation rate, and a simulated zoning board meeting. (BB)

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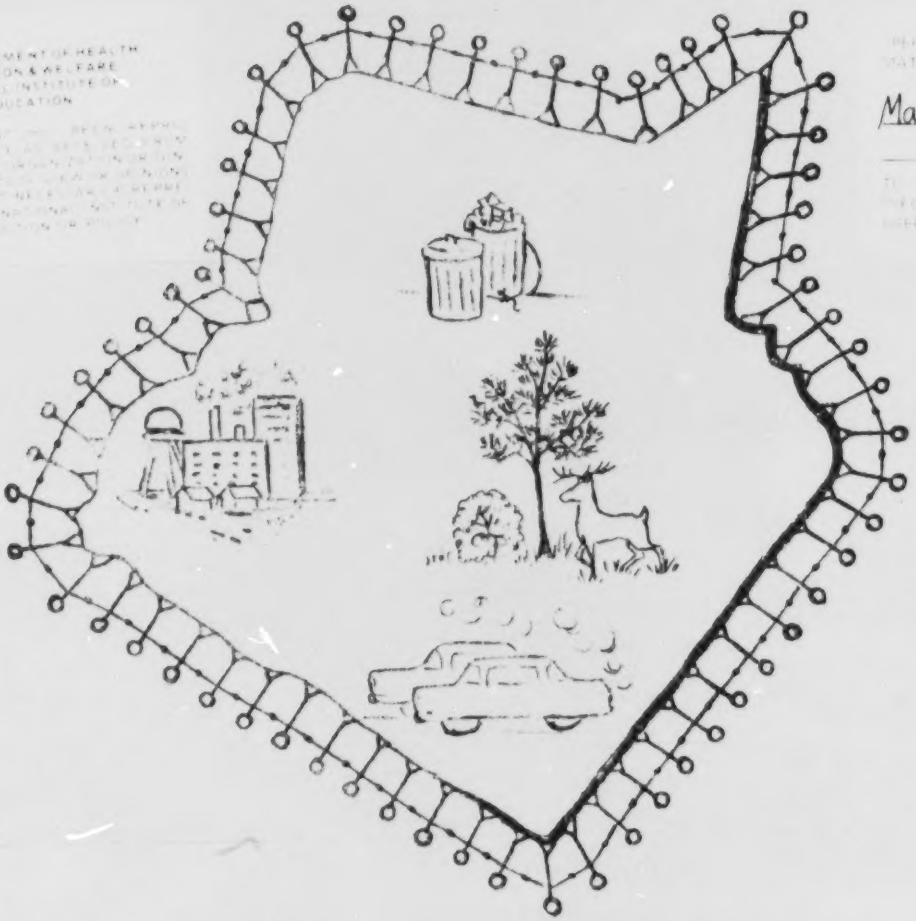

How Much Is Too Much??

U.S. DEPARTMENT OF HEALTH
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GROWTH: HOW MUCH IS TOO MUCH?

Science Module

Prepared for Pilot Testing in Biology Classes

Gwinnett County (Georgia) School System

Revised Edition
(9th-10th Grades)

Coordinated social studies and science modules developed by ENVIRONMENTAL EDUCATION FOR THE SECONDARY SCHOOLS, a Curriculum Project of the College of Education of the University of Georgia, supported by the U.S. Office of Education under the Environmental Education Act, (Project No. 522AH51215). All rights reserved.

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Environmental Education for the Secondary Schools is a curriculum project which developed these instructional materials to help high school students respond intelligently to environmental policy issues. Utilizing local issues to stimulate interdisciplinary thinking and environmental problem solving, the modular materials are coordinated for social studies and natural science classes.

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Environmental Education for the Secondary Schools, 1975-1976

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Hi!

I'm Environmental Eddie. I'll be here in Gwinnett County for a few weeks while you study local environmental problems.

This module is part of an environmental studies unit you will be studying in your science and social studies classes.

I hope you'll enjoy it and learn a lot too!

PART I: GETTING THE FEELING

Our Environment

ECOLOGY: WHAT AND WHY

No living thing can exist in complete isolation, independent of its environment. All organisms, including man, are essentially products of their surroundings, which must provide conditions suitable for life and the activities of life. They depend heavily upon organisms very different from themselves, as well as upon others of their own kind. We are none of us self-sufficient -- from the tiniest microbe immersed in its watery habitat and depending upon the wastes of other organisms for its food, to man, surrounded by the boundless energy of sunlight but unable to use even a fraction of it to sustain his own life.

The scientific study of the interrelationships among living things and their surroundings is called *ecology*. It deals with all aspects of life on earth -- from the physiology and behavior of an individual plant or animal, to the interdependence among the several groups of organisms living in an area, to the effects produced in these organisms by the climatic and geologic factors of the environment. It affects each of us individually and as part of that large group of organisms known as *Homo sapiens*.

Ecology is not something new. Scientists have long been interested in how the organisms living together in an area affect each other, especially where their lives touch that of man. It has only been, however, within the last decade that the word "ecology" has become as familiar to the American public as the words "progress and "health."

Nearly every day we are bombarded with stories of the newest ecological crisis or potential environmental disaster through newspapers, magazines, radio and television. We hear that there is an oil spill off the California coast, a massive fish-kill in Lake Erie, or mercury in Canadian tuna. We are asked to campaign against the draining of swamplands in Southern Georgia and Northern Florida. We are urged to ban large airplanes like the SST and the Concorde. Perhaps the most strident of all the "disaster-mongers" are those who cry out about the dangers of overpopulation, warning that we are running out of room on earth and will soon be unable to feed our people.

Why is there suddenly such a widespread interest in "protecting the environment?" Why is it that everywhere we turn there is talk of pollution or overpopulation? Why should we worry if there are too many or too few deer in the woods? Aside from its distasteful appearance, is roadside dumping <u>really</u> so bad? So what if the alligators and whooping cranes become extinct in order to make room for another airport or shopping center? Do these so-called crises affect us in Gwinnett County, Georgia? If so, in what ways?

The problems that face us are many and varied. Some of them, such as pollution of air and water, are clearly related to our health and comfort regardless of where we live. The effects of others are not always so obvious. Yet each of us, as a citizen, makes decisions concerning these problems -- whether through definitive action or passive indifference. In order to make responsible decisions concerning our environment, we should have some understanding of how groups of organisms affect each other and their surroundings.

Many of our problems today are related to population growth and Gwinnett County is one of the most rapidly growing counties in Georgia, therefore we will direct our attention during this unit to the ways in which natural populations grow and function together in their environments. We will attempt to discover how and why seemingly minor disruptions of an area have far-reaching and often catastrophic effects.

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Does Anyone Know or Care?

CLASS ACTIVITY

An issue may be defined as any subject over which there is controversy or disagreement. When faced with an environmental issue, a citizen may respond by "taking sides" or by just ignoring the entire situation. But his reaction may be merely uninformed opinion or he may attempt to discover facts and scientific principles underlying the issue. The investigation that follows is an attempt to survey the attitudes of some of the people of Gwinnett County toward the issue of local population growth.

Procedure:

(1) Select the one hypothesis from those listed below which you think best reflects the attitudes of Gwinnett County citizens. For the purposes of this study let us assume that "lack of opinion" means "indifferent" and that expression of any opinion means "concerned." Let us also assume that seeking or possessing knowledge about the issue indicates an informed citizen.

   a. Most people are both concerned and informed about environmental issues.

   b. Most people are concerned about the environment but are uninformed about environmental issues.

   c. Most people are indifferent to environmental problems even though they are informed about the issues.

   d. Most people are both indifferent and uninformed about environmental issues.

(2) Try a limited test your hypothesis using the following technique:

   a. Give the attached list of questions to at least four adult citizens of Gwinnett County.

   b. Ask your "sample subjects" to answer the questions as honestly as possible and to record their answers on the data sheet.

ATTITUDE QUESTIONNAIRE

Directions: Read each question completely and choose your response from the alternatives given for that question. Place the letter of your answer in the appropriate blank on the separate response sheet. Please do no write on this page.

1. How do you feel about the recent rapid growth of population in Gwinnett County?

   a. The more, the better
   b. Something should be done to stop or slow it down
   c. It doesn't bother me

2. How would you feel about the possibility of 50,000 more people moving to Gwinnett in the next three or four years?

   a. It's good for the economy -- more people spend more money
   b. It would be terrible -- it is too crowded here already
   c. It doesn't matter -- we'll manage

3. Has the size of the population of Gwinnett changed much since 1970?

   a. Yes, we've almost doubled in size since 1970
   b. Yes, we've got a few (10 or 15,000) more people since 1970
   c. No, it's about the same as its always been

4. Do you see Gwinnett as having serious problems if 50,000 more people suddenly move here?

   a. Nothing more serious than longer lines at the supermarket or service station
   b. Very serious problems with things like disposing of garbage, getting sewage service, or just finding more room for them
   c. Nope

5. Have you attended any public hearings or county board meetings within the past year?

   a. Yes, several
   b. Once
   c. No

6. Have you expressed your opinions concerning population growth to any of your county officials?

   a. Yes, I've talked with some of them and have written letters to them or the newspaper.
   b. Yes, I've talked with one or more of them
   c. Yes, I've written to them or to the newspaper
   d. No I have not

(3) Following the procedure outlined below compile your data on the tally sheet provided by teacher.

1. Answers a or b -- concerned
   Answers c -- indifferent

2. Answers a or b -- concerned
   Answer c -- indifferent

3. Answer a -- informed
   Answers b or c - uniformed

4. Answer b -- informed
   Answers a or c -- uniformed

5. Answers a or b -- informed
   Answer c -- uniformed

6. Answers a, b, or c -- concerned
   Answer d -- indifferent

Examples:
Suppose that the following were the results of one questionnaire

1. a	4. c
2. b	5. a
3. c	6. d

This person's answers indicate he was "concerned and uninformed." Answers to questions 1 and 2 classify him to be "concerned." Answers to questions 3 and 4 indicate that he is "uniformed." See box below.

	Person I	Person II	Person III	Person IV
Concerned	//			
Indifferent	/			
Informed	/			
Uniformed	//			

(4) Interpret your results for each person as follows:

1. Classify as *concerned and informed* any person who has two or more marks in the "concerned" block and two or more marks in the "informed" block.

2. Classify as *concerned and uninformed* any person who has two or more marks in the "concerned" block and two or more marks in the "uniformed" block.

3. Classify as *indifferent and informed* any person who has two or more marks in the "indifferent" block and two or more marks in the "informed" block.

4. Classify as *indifferent and uninformed* any person who has two or more marks in the "indifferent" block and two or more marks in the "uninformed" block.

(5) A large chart identical to the one below will be displayed in the classroom. Transfer your data to the large chart.

	Concerned	Unconcerned
Informed		
Uninformed		

(6) Draw conclusions from the class data as follows:

a. Calculate the total numbers of individuals questioned who could be classified in each of the four groups.

b. Compare your results with the hypothesis that you made at the beginning of the activity.

1. Do your results agree or disagree with your hypothesis?

2. What did you learn by doing this activity?

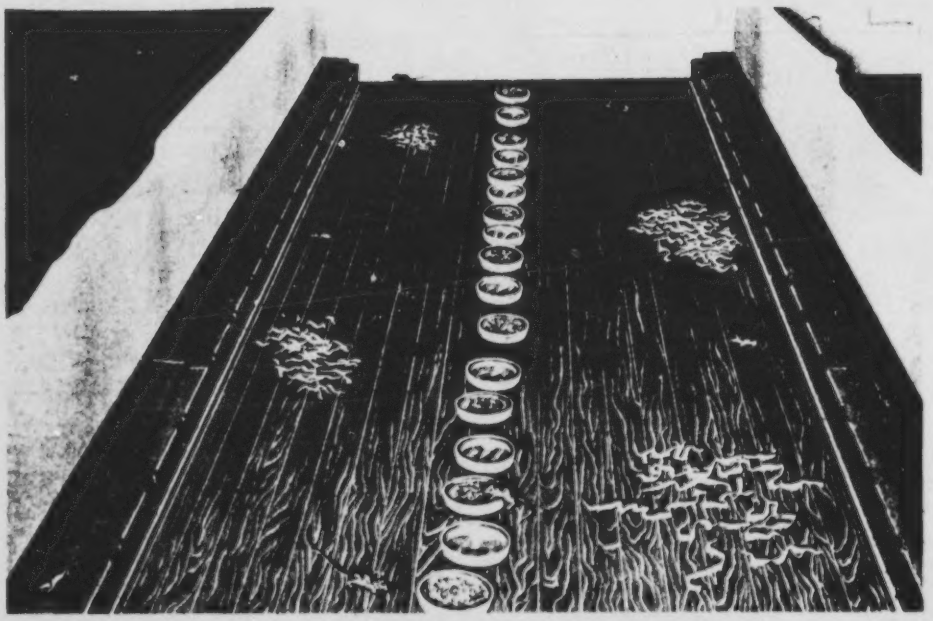
3. How do you feel about your results?

4. Where do you fit in the chart?

(7) The exercise you have just completed follows scientific procedure, however you should keep in mind that the results you have obtained are based upon a very limited and possibly biased sample of people. The conclusions, therefore, do not necessarily reflect the attitudes of all the people of your community.

The Limits of Growth

Class Activity



Several important studies dealing with the effects of density upon population have been done with mice. John T. Emlen and a team of biologists at the University of Wisconsin conducted a series of experiments with a population of mice in the basement of an old building near the university campus. Consider these three experiments:

A. In one experiment they provided the mice with 250 grams of food per day. This amount was more than adequate for the initial population, which grew rapidly. Since the quantity of food provided was not increased, the mice soon began to suffer a food shortage. The biologists began to capture individuals on the upper floors of the building where there had been none previously. There was no evidence of a change in either the number of births or deaths. Evidently, the food shortage within the population had caused some individuals to move out of it.

B. Another similar experiment had been performed earlier in which the only difference was that the mice were confined in pens, so that none could escape. In this case, when a food shortage developed, fewer young were produced and the population stabilized at a level that could be supported by the food supply.

C. A third experiment was then conducted in which the mice were again confined in pens but with more than enough food always being provided. Although food shortage never became a problem; as more and more mice were born, the available space per individual decreased.

Answer the following questions concerning these population studies:

1. What factor in the first two experiments seemed to be most important in limiting the size of the populations?
2. By what means was population growth slowed or stopped in the first two experiments?
3. Were the results in the second experiment what you expected? Why or why not?
4. Is there a growth limiting factor present in the third experiment? If so, what is it?
5. What do you think the findings were in the third experiment?

The third experiment was performed both at the University of Wisconsin and in England, with different findings in both places. In Wisconsin, when the population became "crowded," there was an increase in aggression by individuals within the population. Chasing, fighting, and even cannibalism became common. Young mice continued to be born, but soon died of neglect. Eventually, the number of those born which died before reaching maturity reached 100%.

The English team reported none of the chasing, fighting, and neglect of the young that had been found by the Wisconsin researchers. There was no increase in death rate among the young. Instead, when the population became "crowded," reproduction stopped completely and no new young were produced.

The reasons for the different results in the two cases are uncertain. The researchers themselves believe that differences in the designs of the pens and nesting boxes may have been responsible. The important point for our purposes, however, is that there were definite physiological and behavioral reactions in mice placed in "crowded" environments. A population appears to impose natural limits upon its own growth. In other words, although the factors influencing population density may come from <u>outside</u> the animals, they operate <u>through</u> the behavior of the animals.

Two new questions are now raised: (1) Are the findings from the mice experiments consistent with those dealing with other kinds of organisms? (2) How do populations behave in the "real world" outside the laboratory?

A Population Study Using Microbes

Class Activity

Unicellular organisms are commonly used in the study of population growth. There are two major reasons for this: 1) most such organisms reproduce rapidly, producing new individuals every few hours or even every few minutes. This makes it possible to observe many generations in only a very few days. 2) Their small size permits the study of several populations concurrently within the confines of limited laboratory space.

To test the consistency of the results obtained in Emlen's mice experiments, try to determine if crowded conditions (decreased space per individual) exert a limiting effect upon the microorganism, *Paramecium multimicronucleatum*. *Paramecium* is a slipper-shaped unicellular organism commonly found in stagnant pond water. The tiny hairlike *cilia* by which it moves through the water places it in the protist phylum *Ciliphora*. It feeds on bacteria and tiny particles of food suspended in the water. Begin with a population of 10 Paramecia and make daily counts of your population. Be sure to keep complete and accurate records of your data. Follow the outlined procedure carefully.

Part A

1. Add 6 ml. of innoculated ciliate medium to a petri dish, using the sterile technique demonstrated by your instructor.

2. Add about 10 paramecia to the medium. (3 or 4 days of Paramecian Stock Culture)

3. Tape the cover of the petri dish closed, mark to identify it, and place it in a moisture chamber to be incubated at 24° or 25° C.

4. To make population counts, count 10 contiguous fields at 10X magnification on your stereoscope.

5. Repeat counts daily and keep a record of data.

6. To calculate density of your population:

   a. Calculate the surface area of the petri dish using the formula $A = \pi r^2$.
   b. Calculate the area of stereoscopic field using the formula $A = \pi r^2$. (Hint: use a metric ruler to determine r in both of above.)
   c. Divide the total dish area by the area of one field. Multiply this answer by the average number of paramecia per field. This value equals the total number of paramecia in the dish.
   c. Sample Problem:

Dish area = 100 mm^2 Number of paramecia counted = 100
Field area = 10 mm^2 Number of fields counted = 5

$$\text{Total no. of Paramecia} = \frac{\left(\frac{100\ mm^2}{10\ mm^2}\right)}{\left(\frac{100\ \text{paramecia}}{5\ \text{fields}}\right)}$$

$$= 200 \text{ paramecia}$$

NOTE: Be sure to see your instructor if you have problems with calculations.

Part B Population of Ideal City

The accompanying table is composed of population figures for Ideal City, a regional commercial and cultural center. The time span covered is from 1775, when it was a relatively small frontier town, to 1975 where Ideal City has been recognized as a progressive urban leader. Using graph paper, plot the figures to obtain a population growth curve to see how Ideal City has grown.

Questions for Discussion

1. What would be the population of Ideal City in the year 2000, if it keeps growing at the present rate?

2. Do you think that food or water has ever been a significant factor in determining this growth? Explain.

3. Do you think that the above will ever be a limiting factor of their population growth? Explain.

4. What are two things that probably contributed to the growth of Ideal City?

5. In 2000, will Ideal City have enough room for recreational facilities such as parks, stadiums and swimming pools for all to enjoy? Explain your answer.

6. Do you think it is time for the people of Ideal City to plan for the future? Should they seriously consider limiting population growth?

7. Who in your community is planning for the year 2000?

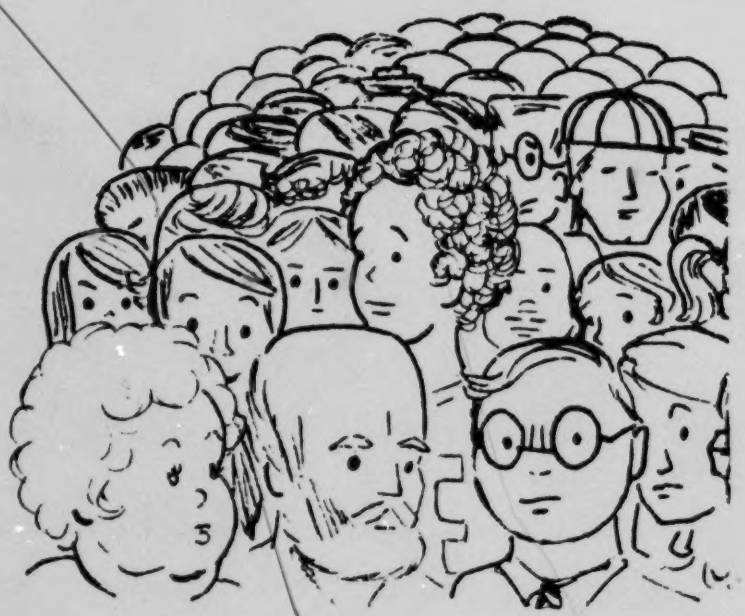
8. When you have completed your microbe study, compare the growth curves for both populations. How are they similar?

Population of Ideal City, 1775-1975

Year	Population in thousands
1975	1710
1950	988
1925	435
1900	271
1875	250
1850	150
1825	75
1800	40
1775	8

PART II: GETTING THE FACTS

Populations



Since the major focus of our investigations is to be the problems of population growth, it follows that we must all have a common understanding of the meaning of the word *population*. It is a term that may be used in several different ways, depending upon the interests of the individual using it. Originally, it simply meant "peopling" or "the number of people inhabiting a place in the world," having been derived from the latin word *populus*, meaning "the people." Today, it may be used to refer 1) to all the individuals of a given species, as when we speak of the human population, or 2) to the individuals of several species, as when an entomologist speaks of the insect population of an area.

While these are perfectly legitimate uses of the term, we will nevertheless use it in the somewhat more restrictive manner used by most biologists. A *population* therefore, is a group of organisms of the same species inhabiting the same locality. A population

may be composed of either plants or animals. Although we will limit our study in this unit to animal populations, it should be pointed out that plant populations behave in similar ways.

One of the most important characteristics of a population is its relative stability. Individuals may multiply or die, emigrate or immigrate, but the basic nature of the population as a whole changes very little. This is due mainly to another characteristic of a population, preferential interbreeding within a common gene pool. Any two members of a population have an equal probability of mating with each other and producing offspring. This means that the numbers and types of gene combinations possible within the population remain relatively unchanged.

Another attribute of populations is that they interact with both the *physical and biotic* components of their surroundings. Although members of a population mate preferentially with other members of the same population, there is occasional mating outside the local group of organisms. The extent to which this occurs depends largely upon the degree of geographical isolation of the population. Other types of *intraspecific* (within species) and *interspecific* (between species) interaction, as well as interactions with the physical environment, will be discussed in a later section of this unit.

Another very important characteristic of population is *density*--or the number of individuals per unit area or volume of space occupied. The choice of space unit used is dependent upon the purpose of the information. For example, an architect designing a school is interested in the number of students per square foot of floor space when planning

room sizes and in the number of people per cubic foot of air when planning for ventilation. Ecologists usually use square dimensions when dealing with population density, such as the number of trees per acre or the number of foxes per square mile.

"We are faced by a most elementary choice. Either we find a way to bring the birth rate down or the death rate will soon go back up. Make no mistake about it -- mankind has not freed itself of the tyranny of arithmetic!"

Paul R. Ehrlich, "The Population Explosion: Facts and Fiction"

Density Determiners

Several factors influence population density. These are known as *density determiners*, because their interaction determines the density of a population at any given time. There are two ways by which new individuals may enter, and thereby increase the size of, a population. They may be born or they may migrate into the area.

There are also two ways by which individuals may leave and thereby decrease the size of a population. These are by death and by migration out of the area. Thelength of time that an individual can be expected to remain within the population, provided emigration does not occur, is known as *survival time* and also affects the size of a population.

Birth rate or *natality* is a characteristic of populations, not of individuals, since an individual is only born once. It is simply the population increase due to the normal rate of reproduction and is considerably lower than the *maximum possible natality*, which would be expected under ideal conditions. This is because ideal conditions, under which reproduction would be limited only by such physiological factors as maximum egg production possible per unit of time, do not exist in natural situations. Natality, therefore, is the *actual observed population increase under a particular set of ecological conditions* and will vary as the conditions change.

The mathematical notation used to express natality is:

$$\frac{N}{T} \quad \text{or} \quad \frac{\text{CHANGE IN NUMBER OF INDIVIDUALS}}{\text{CHANGE IN TIME}}$$

This tells us the production of new individuals per unit of time. For example, the natality rate for a flock of hens producing 120 chicks in 2 months would be 2/day (120 chicks divided by 60 days).

Natality of human populations is usually expressed in terms of the number of live births per one thousand members of the population per unit of time. This is determined using the following formula:

$$\text{Natality rate} = \frac{\text{number of live births for time period}}{\text{size of population at mid point of the time period}} \times 1{,}000$$

The term *mortality* (death rate) is applied to the number of individuals lost from a population due to death by any means, including by accidents, predation, or any other environmental factor. It is

usually much higher than the *theoretical minimum mortality*, which is the number of deaths expected if all individuals die of "old age" at the point determined by their *physiological longevity*.

Mortality rate for most organisms is expressed as the number of organisms dying per unit of time, such as 75 deer dying per year in the population of a certain forest. Mortality of human populations, however, is normally described as the number of dying per one thousand members of the population per year. For example, the mortality rate in the U.S. in 1970 was 9.6 people per thousand.

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Check Your Understanding

1. Define *population*.

2. Explain briefly in your own words why a population may be considered to be relatively stable.

3. Distinguish between interactions that are *intraspecific* and those which are *interspecific*.

4. Define *population density* and give an original example, using dimensions such as an ecologist would use.

5. List the four major *density-determiners*.

6. If a farmer has a herd of cows that produced 180 calves in 3 months, what is the natality rate of his herd?

7. In 1971, approximately 3,769,000 new babies were born in the United States. The total U.S. population in June of 1971 was 207,100,000. What was the natality rate in the U.S. in 1971?

ENVIRONMENTAL INFLUENCES

In preceding sections of this unit, we have been using the word *environment* in a general way, referring simply to an individual's surroundings. This is an adequate definition since environment actually is everything outside an organism itself. There are, however, both biotic and abiotic components making up an environment.

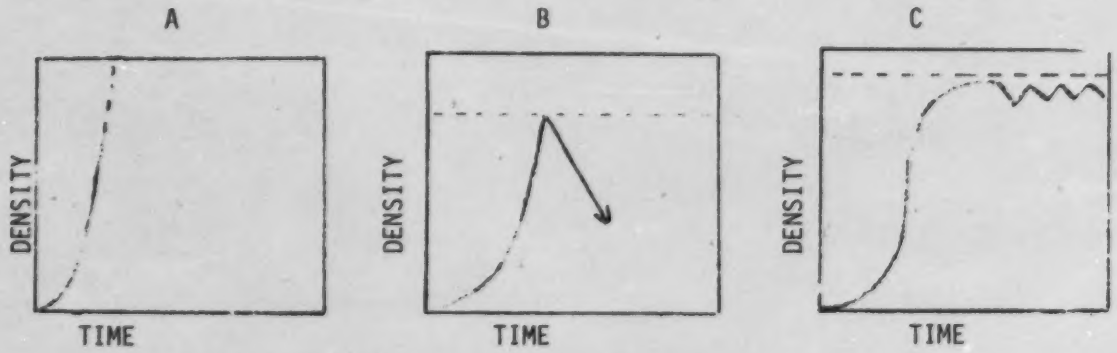
The *biotic environment* includes everything outside the organism itself that is alive or was recently alive such as food or other plants and animals. The *abiotic environment* is composed of all the things in the environment that have never been alive, such as water and soil. Both biotic and abiotic factors in the environment influence the growth and pattern of survivorship of populations.

We have seen that under natural conditions natality is usually far lower and early mortality far higher than would be expected under ideal conditions. One approach to the study of the nature of a population is to calculate the expected growth under ideal conditions and compare with the actual growth. In this way, we can see how environmental conditions have modified the population. For example, we could assume a population with a stable age distribution which faces no predation, parasitism, or competition, and has access to unlimited resources. The maximum potential rate of growth for a population under such ideal conditions is called the *biotic potential*. In other words, in the total absence of growth-restraining factors, biotic potential equals maximum natality less minimum mortality. Biotic potential may be measured under controlled conditions in the laboratory or from estimation of total egg production.

Calculations of biotic potential were important to Charles Darwin in his formulation of the theory of natural selection. Using information such as the usual number of offspring produced and the expected physiological longevity of elephants, he himself concluded that after a period of about 750 years there would be almost 19 million elephants alive descended from a single pair. If we extended the time period to 100,000 years, the living descendents from one pair of elephants would be so numerous that they would fill "the visible universe."

Why don't such astounding population explosions actually occur? The obvious answer to this question is that there are always limiting factors on any population that prevent its reaching its full abiotic potential. The difference between the biotic potential and the actual growth rate is the total of all the *environmental resistance*. The interaction of the biotic potential and environmental resistance results in a characteristic pattern of increase or *population growth form*.

Population Growth Form



If a population were not acted upon by limiting factors, it could reach its full biotic potential and its growth curve would rapidly approach the vertical. Curve A in the figure above represents just such a hypothetical case, in which population density increases exponentially. The more individuals that are added to the population, the faster its growth increases since the new individuals also reproduce.

The J-shaped curve, illustrated by Figure B, is also exponential and differs from the hypothetical only in the introduction of environmental resistance factors. In some populations, limiting factors have little impact until late in the increase and the growth pattern approaches the ideal. A sudden rapid decline in density occurs when these limiting factors abruptly become effective. This kind of population growth pattern is found in populations of insects with short life spans. Rapid population growth occurs during spring and summer, crashing rapidly when the weather changes.

The normal growth curve for most natural populations is the S-shaped curve, Figure C. At first the increase is slow, then it becomes rapid, and finally declines as the population nears an equilibrium position within the confines of the environment. This equilibrium position is at or a little below the *carrying capacity* of the environment -- that is, the maximum population it is possible for the environment to support for an extended period of time.

What determines the carrying capacity of an environment? What are the factors that regulate or limit the size of a population?

To consider these questions, we must examine the components of environmental resistance.

The limiting factors which always slow or stop the growth of populations are components of environmental resistance and may be either biotic or abiotic. They are commonly grouped into two categories: *density-independent and density-dependent factors*. Any factor whose influence increases as population density increases and decreases as density decreases is said to be density-dependent. A factor is said to be density-independent if its effect, whether limiting or favorable to a population, is constant regardless of density.

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Density-Independent Factors

Density-independent factors are almost always *abiotic* in nature and exert equal influences on populations without respect to their sizes. Examples of such factors are soil, ground water, radiation and geographic terrain. Climatic factors such as amount of sunlight, rainfall, temperature, and those environmental phenomena loosely called "weather" are also density-independent in their effect. Heavy rains, floods, and seasons of drought are equally destructive to both large and small populations. To paraphrase a common cliche: "The rain falls on the small and on the large."

Human destruction of natural environments, pollution, and pesticide use are also indiscriminate in their effects upon populations. For example, when we strip a forest of its trees or drain a swampy lowland in preparation for development or cultivation, native animal populations are greatly reduced or even wiped out regardless of their density. Without nesting areas, sources of food, and shelter from voracious enemies, these animals must migrate or die. And what if there is no place for them to migrate to? Or what if they are not physically equipped for extensive migration?

Wildlife populations have been drastically reduced in recent years due to the widespread use of pesticides. The degree of mortality caused by these poisons is independent of the size of the populations affected. In forested areas sprayed with DDT for the control of the Dutch elm disease, robin populations declined 69 to 98 percent below

those in unsprayed areas. The robins were poisoned by eating earthworms which had been feeding on the decayed leaves in the soil beneath the sprayed trees.

Density-Dependent Factors

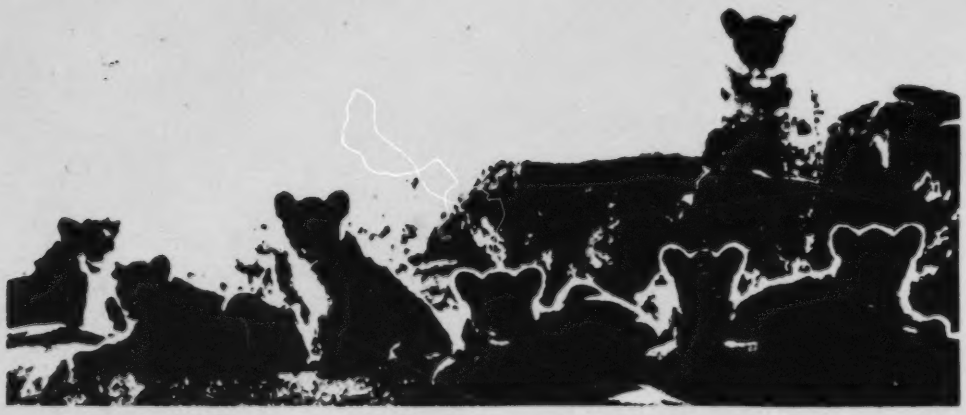
The equilibrium population sizes seen at the upper end of S-shaped growth curves are functions of density-dependent factors. These factors are in operation throughout population growth, but their effect intensifies as the carrying capacity is approached. At this point, production of new individuals balances the loss of individuals through death and emigration.

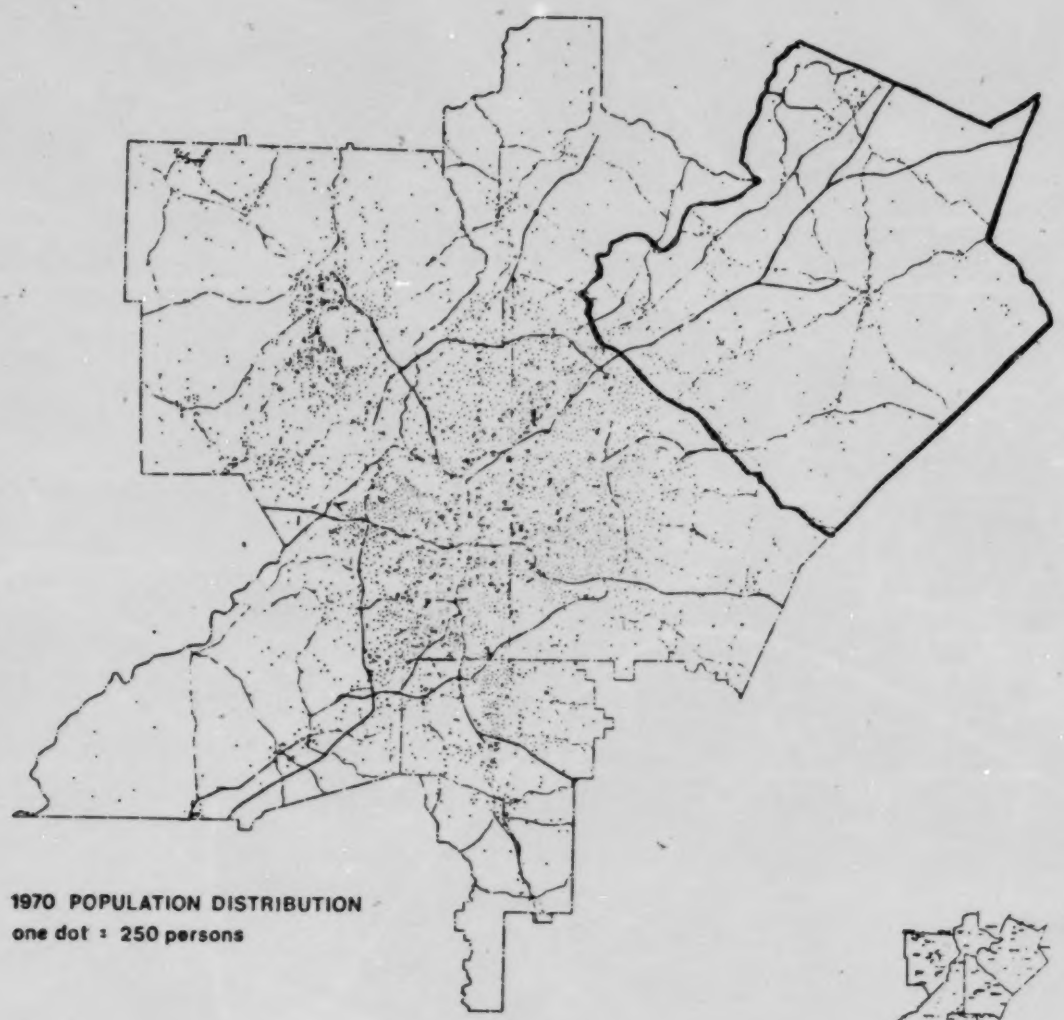
If population size rises above this equilibrium density, the effect of the density-dependent factors becomes even stronger and increases the rate of loss. Should density fall below the equilibrium density, the effect of these factors is reduced and the population is permitted to grow. Since there is a time lag between cause and effect due to the time required for growth and reproduction, population size fluctuates somewhat about the equilibrium density. However, since density-dependent factors are the ones primarily responsible for this fluctuation of density near the carrying capacity of the environment, they are considered to be most important in the regulation of populations.

Density-dependent factors usually involve interactions between organisms and are therefore *biotic* in character. Agents such as *parasites, pathogens (disease-causing microorganisms), and predators* are examples of limiting factors whose influence vary with population

size. When populations are of high density, parasites and pathogens are more easily spread from organism to organism. Through their action, they then reduce the density of their host population through increasing its mortality. High-density populations also make it easier for predators to find prey, which effectively reduces the prey population.

Another very important density-dependent factor is *intraspecific competition,* competition by individuals of the same species for a resource in limited supply. One of the limited resources which is usually the object of such competition is food, an absolute requirement for all living organisms. As long as the population size remains at or below the carrying capacity of the environment, members of the population do not feel the stress of competing for it. Once the rate of reproduction becomes excessive, however, food shortages develop and the result is an increase in mortality, especially among the young and weak, and in migration out of the population.





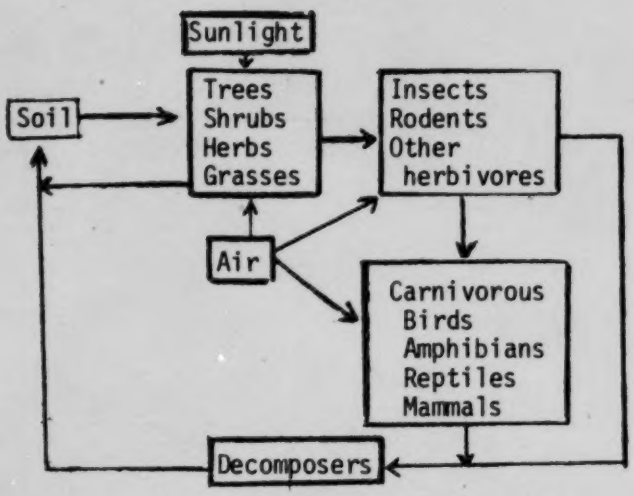
1970 POPULATION DISTRIBUTION
one dot = 250 persons

HOW POPULATIONS INTERACT

Great fleas have little fleas upon their backs to bite 'em,
And little fleas have lesser fleas, and so ad infinitum.

Augustus de Morgan (1872)

No species of organisms can totally divorce itself from relationships with other species. Even populations of simple microorganisms such as the paramecia we are using in our population study behave in quite complex ways. Such behavior is a web of interactions with the physical environment, within the same species (intraspecific), and between populations of different species (interspecific). All of the relationships within this web affect the character of a population and may cause fluctuations in its growth curve. The diagram below illustrates such a web.



Several types of interspecific interaction have already been mentioned briefly as examples of density-dependent factors of the biotic environment. The three basic types are predation, symbiosis, and competition. We shall now consider each of these in more detail in an attempt at understanding their ecological outcomes.

Predation

Predation is the behavior of capturing and feeding on another organism, which is consumed wholly or in part and may be either plant or animal. Predators that eat other animals are called *carnivores* and those that eat plants are called *herbivores*. The organism that is consumed in a predatory relationship is called the *prey*.

We are all familiar with many animal predators. Hawks, wolves, lions and even our domesticated cats and dogs are predators. Man, too, is a predator, although indirectly through the slaughterhouse and the farmer in our modern civilization.

The effect of predation on a prey species varies. The numbers or distribution of the prey may be drastically limited, even to a point far below the level that the environment could support. This can occur when a new predator-prey relationship develops, as when man introduces a new species into a region or alters the environment in some way. In such a case, the organisms require a period in which to become adjusted to the factors in their environment.

There are also situations in which the predator has little effect upon the prey population, either because its own numbers are so few or because it commonly utilizes some other food source. The usual case in

predator-prey relationships, however, is somewhere between the two extremes. The degree of predation is thus sufficient to limit growth of the prey population, but not to the extent of potential extinction.

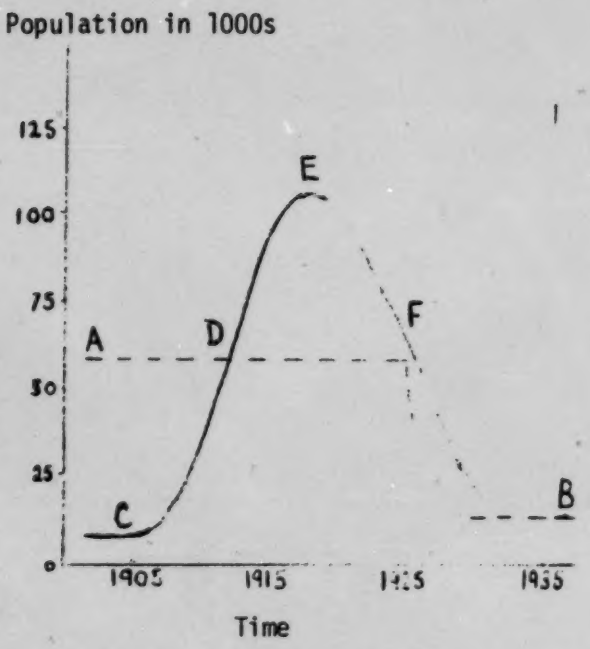
Prey populations influence the densities of predator populations, just as their densities are influenced by the predators. The result is often a series of closely corresponding density fluctuations in both populations. At high population density levels, individual prey are easier to capture. They may be forced into less favorable environmental conditions or be physically weakened due to drain on environmental resources. Because of this, predators that normally feed upon a variety of species tend to alter their hunting patterns and concentrate upon those prey which are most common. Under such favorable hunting conditions more of the predators survive longer and reproduce more young, increasing the density of the predator population.

The increase in numbers of predators causes a decline in the numbers of prey, as more and more of them lose their lives to hungry hunters. As decreased density of prey makes individuals harder to find and capture, there is often a corresponding decrease in predator population -- especially where there is no alternate food source readily available.

It is easy to see how a series of alternately rising and falling densities of the two populations would develop, with densities of the predators closely following those of the prey. Characteristically there is a time lag between the fluctuations of the two populations. The close correspondence between the behaviors of predator and prey populations suggests that predation is an important limiting factor

for the prey and that the availability of its food is the major limiting factor for the predator.

Although harmful to the individuals that are eaten, predation is nevertheless beneficial to the prey population as a whole. This fact of ecological balance is often overlooked or misunderstood. An example of such misunderstanding and the consequences of it occurred a number of years ago on the Kaibab Plateau in Arizona.

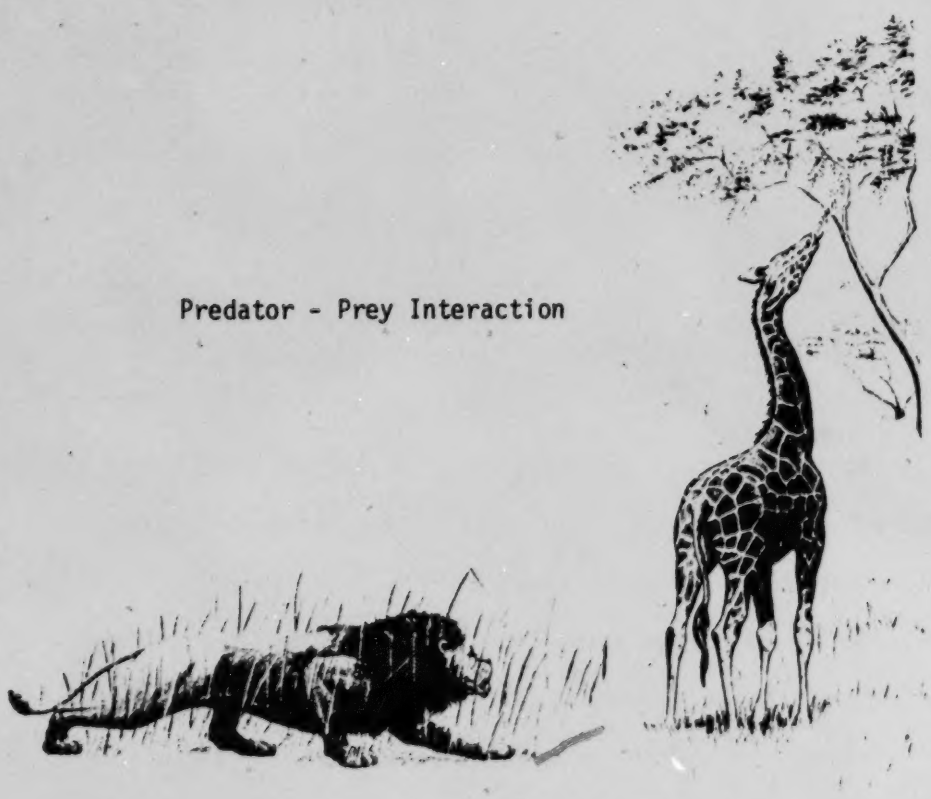


Destructive effect of upsetting ecological balance of populations.
(a) Normal carrying capacity of Kaibab Plateau.
(b) Reduced carrying capacity following overgrazing.
(c) Herd population kept low by predators.
(d) Predators eliminated.
(e) Overpopulation
(f) Death of deer due to starvation.

Prior to 1907, there was a stable population of about 4000 deer living on the plateau. This density, which was well below the carrying capacity of the area, was kept relatively constant by healthy populations of pumas and wolves. In 1907, however, there began a misguided effort at elimination of these "enemies" of the deer. By 1923 the predator populations had been exterminated and by

1925 the Kaibab deer population had risen to 100,000. This number of deer was far above the carrying capacity of the environment and the area was soon stripped of vegetation. During the next two years, over half of the deer starved to death and the population continued to decline for many more. The balance of the entire area had been disrupted. Removal of the predator species not only proved destructive to the deer population, but apparently lowered the carrying capacity of the range as well.

Predator - Prey Interaction



Population Fluctuation Through Predation

Class Activity

Table 1

Year	No. of Hares
1845	20,000
1847	12,000
1852	85,000
1854	75,000
1855	60,000
1860	17,000
1861	22,000
1862	20,000
1864	148,000
1868	5,000
1870	5,000
1875	102,000
1880	15,000
1885	135,000
1890	25,000
1895	95,000
1900	2,000
1905	70,000
1908	25,000
1912	70,000

Table 2

Year	No. of Lynxes
1846	43,000
1850	5,000
1852	5,000
1855	35,000
1860	5,000
1863	10,000
1866	65,000
1870	10,000
1873	15,000
1875	40,000
1880	15,000
1884	65,000
1888	10,000
1891	10,000
1894	50,000
1897	20,000
1900	1,000
1903	65,000
1908	10,000

Tables 1 and 2 above are based upon the actual data collected by the Hudson Bay Company in Canada from 1845 to 1912 concerning the relative numbers of snowshoe hares and Canadian lynxes.

1. Construct a line graph from the data in the two tables. Both sets of data should be placed on the same graph, so use a different color for each species. Connect graph points with a smooth curve.
2. Describe any relationships between the patterns of fluctuations that you obtain with your graph.
3. Describe the nature of the density fluctuations in the lynx population between the years 1890 and 1900.

4. Speculate as to the cause of the fluctuation described in question 3.
5. What do you think happened to the lynx population by 1912? Why?

Symbiosis

Symbiosis is another type of interspecific interaction in which two species live together in a long-term, relatively intimate association. The term itself literally means "living together" and carries no evaluation of benefit to either species. There are three general types of symbiotic relationships: *commensalism*, in which one species benefits and the other is apparently unaffected; *mutualism*, in which both species benefit; and *parasitism*, in which one species benefits while the other is harmed.

In *commensalism*, one species lives in close association with another in order to obtain some advantage such as shelter, support, transport, or food. The second species in such relationships obtains no benefit nor is it usually harmed.

An interesting example of commensalism between two animal species occurs between certain species of fish and sea anemones. Sea anemones have numerous tentacles which they use to paralyze and capture the fish which they feed upon. Certain fish species live in close association with the anemones, swimming unharmed among the mass of potentially lethal tentacles. The fish benefit from the shelter and protection offered by the anemone and

occasionally even steal some of its food. The anemone apparently neither gains nor loses in the relationship.

A commensal association with which we are all familiar exists between cockroaches and man. The cockroaches benefit greatly by sharing man's food supply but humans are seldom harmed or benefited by having such "guests" in their homes. Although they may not be aesthetically pleasing to have around, their food consumption is hardly enough to injure their hosts.

The most familiar examples of *mutualistic* associations are found in the plant kingdom. Lichens, for example, are composites of an alga and fungus. The fungus receives nutrients from the photosynthetic alga, while supplying its benefactor with water and support. Other examples are relationships between flowering plants and their bee or bird pollinators and between human beings and the bacteria that synthesize vitamin B_{12} in their intestines. In Africa, a bird called a honey-guide flies along in front of a small mammal called a ratel or honey-badger and leads it to a nest of bees. The ratel then tears open the nest for the honey and the bird feeds on the honeycomb.

Many domesticated animals share in a mutualistic relationship with humans. They receive shelter, protection, and food from their human masters, giving some of their products or companionship in return.

Parasitism, like predation, is often an important density-dependent limiting factor in population regulation. There is no sharp distinction

between the two, but there are significant differences that can be used to distinguish between them. The following table outlines these differences.

Parasite	Predator
Feeds on a host Smaller than host Lives on, in, or near host Kills host slowly or not at all	Feeds on a prey Usually larger than prey Associates with prey only when feeding Kills prey quickly and consumes at once

Parasites may be either external or internal. Those which are external live on the outer surface of their host and feed on hair, feathers, scales, skin, or blood. Examples are ticks, fleas, lice and mites. Internal parasites may live embedded in muscles or organ tissues, inside individual cells, or in the tubes and passages of the host's body. Examples are roundworms, tapeworms, hookworms, viruses, and some bacteria and protozoa.

Study of Symbiosis

Class Activity

In this activity you will observe some organisms that are symbiotic. That is they live together in a long-term, relatively intimate association.

As you have learned, there are three general types of symbiotic relationships; commensalism, mutualism, and parasitism. You may wish to review pp. 38-39 for definitions and examples of these categories prior to beginning this activity.

When you finish this activity you should be able to:

- Define and give examples of the three major categories of symbiotic relationships
- Identify the types of relationships observed during this activity
- Explain the benefits or harm received by each symbiotic organism

Each group of students will need:

compound microscopes
slides
cover slips
eye dropper
small test tube with saline solution
forceps, 2 pair
sterile cotton swabs wrapped in aluminum foil, 2
sterile nutrient agar petri plates, 2
termites
perserved tapeworms
prepared slides of tapeworms

Procedure:

Part A Skin Friends or Foes?

Carefully place two covered petri dishes containing nutrient agar media on your desk. Examine them closely (don't open!). Do you observe any cloudy areas or "blotches" on the surface of the agar? If you do, report them to your instructor.

Next, obtain a sterile swab wrapped in aluminum foil and remove the swab being careful not to touch the cotton end. Now, gently rub the cotton swab over the surface of your arm and then "streak it" across the surface of the agar in one of your plates (when streaking, just gently rub the swab on the agar so as not to dig into the surface). Replace the cover and label your dish with your name. On the other dish mark it "control."

The dishes should now be incubated at 32^{o} C until the next day, when you will again observe them for any changes. Go ahead to work on Parts B and C. (When you have completed Part A consider these questions.)

1. What do you think that you may have transferred from your skin to the plate?
2. Why were the dishes and swabs sterilized before using?
3. Are the organisms living on your skin beneficial or harmful? Explain your answer.
4. Why was a control plate included in the procedure?

Part B. Observations of Termites and Their Companions

Obtain a termite and place it on a clean microscope slide. Grasp the insects abdomen with one pair of forceps and its thorax with the other. Now separate the abdomen and thorax by gently pulling them apart. Place the abdomen's contents on the slide and discard the thorax and head. Using your eye dropper, place a drop of saline solution on the slide as to moisten the specimen and then cover with a cover slip.

Observe your slides with the microscope, first with low power and then with high power. Do you observe any ciliates? (Remember, ciliates are protozoa that have cilia).

These ciliates, live in the termites intestine and help digest cellulose that the termites ingest. Without this help the termites could not survive. They would starve.

1. What benefits do the ciliates provide for the termites?
2. Do you think the ciliates may obtain some benefits from this relationship? Explain.
3. What type of symbiotic relationship is involved between the termites and ciliates?

Part C. Tapeworms and Mammals

Tapeworms live in the small intestines of many mammals and feed on the host's digested food.

Observe one of the preserved tapeworms (leave it in the bottle, because they are soft bodied and may easily break apart). You should note that one end of the worm is larger and broader than the other. If you look closely here, you should be able to see that the body is made up of a series of segments. Each segment is full of eggs and as the worm matures, these segments break away and are passed from the host's body via food wastes, to later infect other mammals.

Now, observe one of the prepared tapeworm slides under the microscope. Find the scolex (head) which can be identified by its many hooks and suckers. Move the slide along until you can identify a medium sized segment. Can you identify the numerous eggs?

1. What type of relationship is illustrated by the tapeworm?
2. What adaptations enables the tapeworm to remain inside the host?
3. Explain the difference between a parasite and predator.

Competition

The last of the three major types of interspecific interaction is competition. It is a relationship in which both species involved are subject to harm. It occurs when populations of different species must compete for some limited environmental resource such as food, water, space, or light. The results of such competition are the same as the results in intraspecific competition, except for the fact that two different populations are caused to fluctuate.

As an example, let us consider populations of rabbits and deer, both feeding upon the vegetation in an area. As long as there is an abundant supply of food, both populations will increase rapidly. However, these larger populations make ever higher demands upon the food supply until food shortages develop. Rabbits and deer are then forced to compete more intensely within their own populations and with members of the opposing population. Numbers of both rabbits and deer inevitably decline to levels within the carrying capacity of the environment.

Check Your Understanding

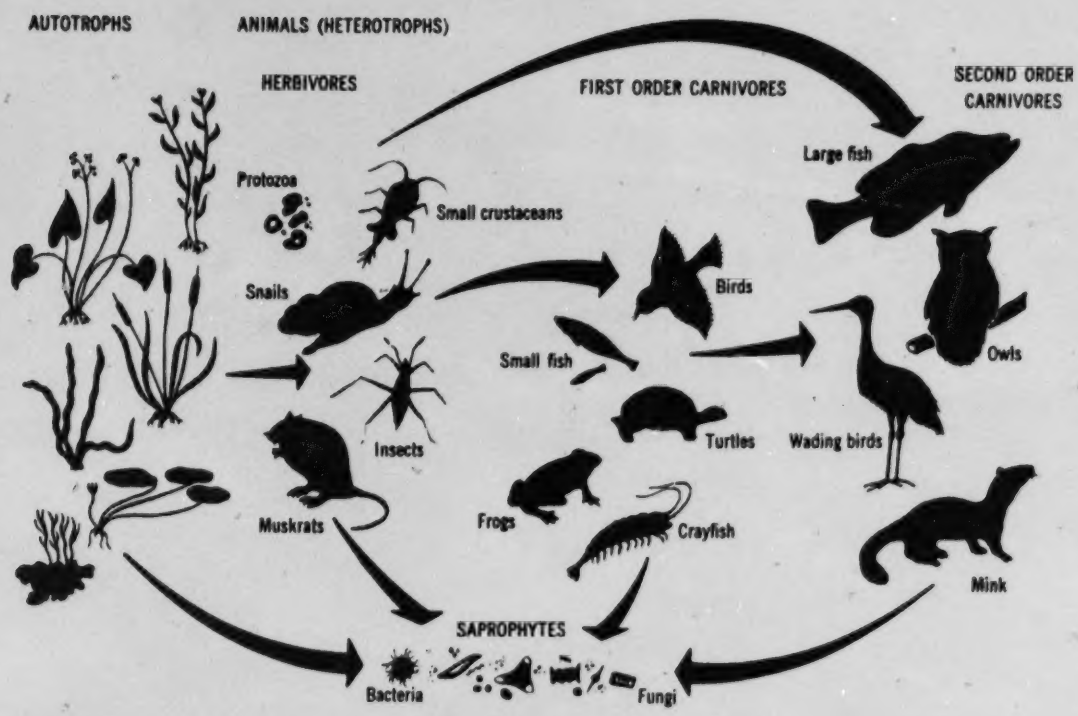
1. Distinguish between intraspecific and interspecific interactions. Give at least one example of each.
2. Name and distinguish between the three major types of interspecific interactions.
3. Describe briefly in your own words how predation affects the two populations involved.
4. Distinguish between the three types of symbiotic relationships giving at least one example of each.
5. Briefly compare and contrast parasitism and predation.
6. Describe briefly in your own words how interspecific competition affects the interacting populations.
7. For each of the following, briefly describe one situation in which humans are one of the interacting populations. Try to think of examples not given in the text.
   A. predation
   B. commensalism
   C. mutualism
   D. parasitism
   E. competition

THE BIG PICTURE

The organisms involved in the intraspecific and interspecific interactions of populations make up a *biotic community*. That is, a biotic community is composed of all of the organisms of all species which live and interact within a particular area. When we speak of a pond community, for instance, we must include all of the plants living in the pond, from the algae floating near its surface to the reeds growing in its shallows, and all of the animals, from microorganisms, snails, and fishes to the turtle resting on a partially submerged log.

As we have already discussed, however, organisms interact with their physical environments as well as with each other. Therefore, in order to complete the picture of an environment we must consider the physical components too. This composite of biotic community and physical environment in an area is known as an *ecosystem*. Within the confines of an ecosystem may be found all the different types of interactions that we have studied plus many others, with each of the components influencing and being influenced by each of the others.

An ecosystem is not just a haphazard conglomerate of unrelated species of organisms with a little soil, water, and sunlight thrown in for good measure. It is an orderly assortment of living and nonliving things, each with its own specific purpose.



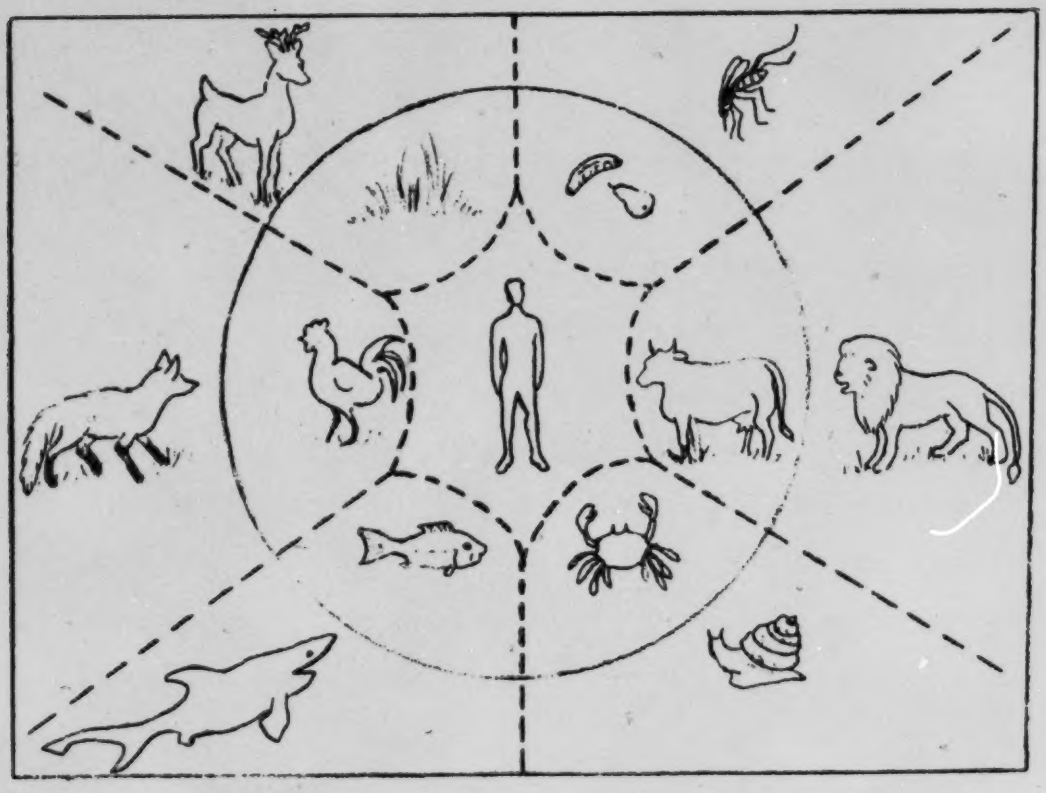
Niches

The position and functional role of each organism within an ecosystem is unique to that organism and is known as its *niche*. Another way of saying the same thing is that an organism's niche is its own unique way of life. It includes the *habitat*, the physical place where the organism lives, and *adaptive strategy*, the things that an organism does to acquire energy and make its living. Adaptive strategy of an organism involves such things as what it eats, how and where it gets its food, what climatic factors it needs and what its relationships with other organisms are.

It has been stated that a niche is unique for each kind of organism. This concept has been restated by some ecologists in terms of the *competitive exclusion principle*, which says that no two species of organisms can long occupy the same niche at the same time.

What this means is that if two different species occupying the same niche should come together in space and time, one of three things will generally occur: 1) one species may be so much superior in its competitive capabilities that it will drive the other to extinction; 2) one may be superior in some areas while the second is superior in other areas with different environmental conditions, with a resulting change in the distributions of both; or 3) the two species may rapidly evolve greater differences in their niches as a result of their intense competition.

Of course, our logic should tell us that the niches of no two species could be identical even if the space and time that they occupied were the same. However, the separate niches of different species do often overlap; that is, portions of niches in an ecosystem may be shared simultaneously by two different species. We saw an example of this when we discussed the interspecific competition for food between deer and rabbits in the preceeding section of this unit. The principle of competitive exclusion is only an extension of the same idea.



The above diagram represents the part of man's ecological niche that is characterized by food requirements. The organisms used for food by man are illustrated within the circle. The same organisms are also parts of the ecological niches of other animals, as indicated outside the circle. These other animals, however, also use foods that man does not. Thus, even though these various niches overlap that of man, the separate and unique character of each is preserved.

This scheme is, of course, greatly simplified and incomplete. It is important to remember that a niche is composed of much more than food requirements. Geographic territory, products, structures, behavior, and many other factors make up the ecological niche of each particular species.

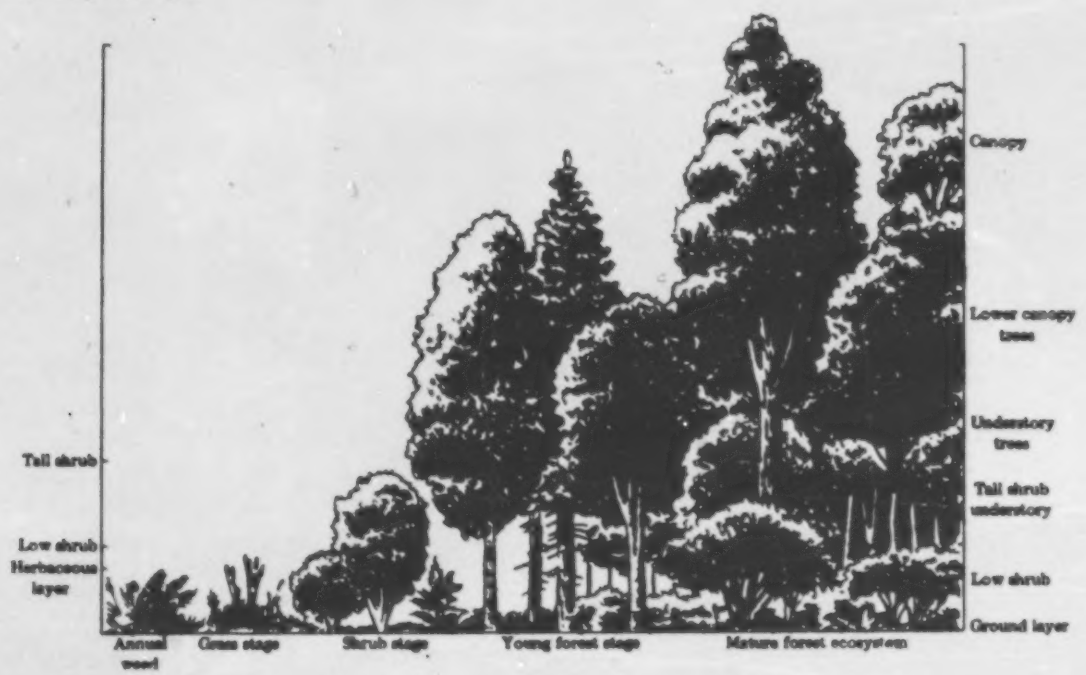
Check Your Understanding

1. What makes up a biotic community?
2. How is a biotic community different from an ecosystem?
3. In your own words, define ecological niche.
4. How is a niche different from a habitat?
5. Briefly explain what is meant by the competitive exclusion principle, including what happens if it is violated.
6. Briefly explain in your own words how the unique identity of each ecological niche is maintained even when there is overlap with another.
7. Do you think that the niche is the same for all populations of a particular species? Explain your answer using man as an example. Be specific wherever possible.
8. Describe how the concept of ecological niche can help to explain the great diversity of living things.

Ecological Succession

Change in a natural biotic community is a more or less constant process. New species migrate into an area; old ones leave or die. This continuous process by which one community is gradually replaced by another is called *ecological succession*. It occurs as an orderly progression through a series of relatively transitory communities until it terminates in stable *climax community*.

We can see examples of newly-begun succession along sandy ocean shorelines, in clear-cut forest areas, and in "dry" ponds that have been filled in with sediment. In the early stages of succession, the communities are quite simple and the variety of species is small. Grasses or annual weeds are often the dominant species in these early stages. Lichens are excellent *pioneer* organisms in the first organic community established on a newly-exposed rock surface. As succession continues, more advanced organisms gradually begin to predominate in the community.



You have probably seen many examples of early succession here in Gwinnett County -- perhaps an abandoned field near where you live. Succession occurs rapidly in such places because the nutrients and other necessities are already present in the soil. Annual weeds such as ragweed and crabgrass will spring up during the very first year. During the second year, ragweed, goldenrod, asters, and tall grass will be abundant. For several years, the grass will be the dominant species in the community and then shrubs and young trees will begin to appear. The first trees to flourish will be pines, since they can tolerate the unshaded field. Soon a pine forest will have replaced the grasses and shrubs. In the hill sections of northern Georgia, succession often ends with the pine forest. However, in those sections of the state where more moisture and nutrients are retained by the soil, deciduous forests eventually replace the pines. The forests are the climax communities of Georgia and, as such, are stable. If left undisturbed by major disasters, such as fire or the interference of man, they will maintain themselves for a long time.

Investigation of a Local Community

Class Activity

Louis Agassiz, a famous nineteenth century oceanographer, once said, "Study nature not books." This applies especially to our study of ecology or environmental science. In your local area there are many opportunities to apply what you have learned thus far. A woodland, vacant lot or pond--each is an example of a <u>community</u> made up of biotic and abiotic factors

interacting with one another. Each has a group of producers (pine trees, grasses, or water plants) that capture the sun's energy. They are subsequently consumed by beetles, mice, rabbits or other herbivores. Eventually this matter and energy is passed on to carnivores or saphrophytes in an endless chain with each link interdependent with the other.

When you visit a local community try to discover the answers to the following questions:

1. What typesof abiotic factors are present?
    a. soil
    b. light intensity
    c. terrain
    d. humidity
    e. temperature variations
2. What are the major groups of autotrophs, hetereotrophs and saphrotrophs?
3. Attempt to construct a food chain or food web.
4. Can you identify any symbiotic relationships?
5. Do you think the same type of community was present 50 years ago? Explain.
6. What changes, if any, would you expect to see in the community if you were to revisit it in the year 2000?
7. Are there any signs of pollution?
8. Is this community in a stage of succession? If so what do you think the next stage will be?

Check Your Understanding

The section you have just studied concerned the succession of plant populations in biotic communities. Consider what you have read and answer the following questions. Discuss your ideas with the rest of the class.

1. Arrange the following in correct order of succession from left to right: shrubs, annual grasses, soil, trees, fungi and lichens, sand, perrennial grasses.
2. What do you think causes succession to occur?
3. Do you think that succession would be the same in Maine or Colorado as it is in Georgia? Support your answer.
4. What reason can you give for the fact that climax communities are more stable than the intermediate communities?
5. Do you think that succession also occurs in animal populations? Why or why not?
6. If your answer to question 5 is yes, describe the kinds of changes in animal populations you would expect to see.
7. Relate the concept of niche to ecological succession.

PART III: GETTING INTO A PROBLEM

The Land Use Question

WHY PLAN FOR LAND USE?

"We have over 115,000 (people) right now, and we will nearly triple in size in 25 years. We must plan for these people and this is what we are trying to do . . . ."

Ken Ealy, Gwinnett County Planning and Zoning Department

"We looked at all the problems that DeKalb had had, Clayton had had, Atlanta and Cobb County as they were growing. Where they made mistakes, we looked at them and we didn't put them into effect. We took all their good parts (that had been successful) and then we tried to establish a 30-year plan.

Out biggest problem in Gwinnett right now is that the growth started and the population increased so fast that we were not expecting it. . . ."

William Atkinson, Chairman of Gwinnett County Board of Commissioners

In the preceding sections of this unit, we have learned that communities of plants and animals that share a common environment function as closely interrelated units. Factors that influence one population, usually indirectly influence others within the ecosystem as well. As an ecosystem matures, the community becomes more diverse. This diversity is important in maintaining the stability of the entire system. This is because a community composed of a great variety of organisms is less subject to destruction if one population suddenly increases in numbers or becomes extinct.

However, as man's population density has steadily increased throughout historical times and his technological repertoire has mushroomed to the point where man is a tremendous agent of environmental change, his power has in many cases been disruptive and destructive to this natural balance.

Most people are aware that many major rivers and lakes are polluted with industrial and domestic wastes. Once productive farms lie eroded and the air is sometimes dangerous to breathe. Some say this is the price that we must pay for progress-- for automobiles, television and air conditioners. Others, however, say no. We can enjoy the products of industrial technology and avoid destruction of land and resources. Their answer involves planning--planning for the future, planning for the best uses of land and other resources with the least harm to nature's balance.

An example of a major disaster to a region and a nearly complete destruction of land is reflected in John Steinbeck's Grapes of Wrath. During the great depression, sections of the Great Plains were affected by several years of drought which created vast dust bowls in once highly productive regions. Thousands of farm families emigrated and

suffered severe financial loss and social stress. Many scientists believe that proper land-use planning coupled with sound agricultural practices could have reduced much of the loss. In fact, the planting of rows of trees to act as wind breaks the employment of contour plowing and irragation have, in recent history, minimized the effects of droughts.

Whether we are speaking on a national, regional or local level, we really have two choices. The first is to ignore history, do no planning and let technology and nature run it's course. The other is to decide what we wish to preserve and what we wish to achieve. By planning for the future and implementing technology, we certainly can avoid the plight of the Kaibab deer whom you read about in Part II. You recall that their land was very nearly destroyed by overpopulation and consumption of resources.

Land Abuse and Overuse

Class Activity

Answer the following questions concerning the destruction of our recreational areas and discuss your answers with the rest of the class.

1. What examples of the effects of overuse have you seen in recreational areas recently?

2. What kinds of effects on the land would you expect to see if current overuse continues for the next ten years?

3. How would you expect streams, lakes, or other bodies of water in the area to be affected if overuse continues?

4. What do you think the overall consequences of this abuse of the land will be?

5. What solution do you see for this problem?

6. What other types of land abuse can you think of?

Warning Sign

When the weather bureaus broadcast tornado or hurricane warnings, people prepare to protect themselves, their families, and their property. Glass windows and doors are quickly taped or barricaded, children are hurriedly collected from schools, volunteer fire departments and rescue squads are mobilized to be ready for the emergency. In coastal areas that are exceptionally prone to hurricanes and high winds, developers and homeowners often build basements or "storm cellars" into their construction designs, owners of mobile homes are required by law to provide sufficient anchorage for their property.

Warnings of a much more sinister and all-encompassing catastrophe have fallen on deaf ears in cities all over the United States. For centuries, space or land area has been recognized as a vital and *limited resource* in Great Britain, Japan, and Western Europe. But for those of us living in the United States, the proverbial "land of wide open spaces," has seemed inexhaustible.

What did it matter if we gouged huge ugly pits in our mountains? Who cared if we stripped naked our forests? So what if we smothered acre after acre of level, fertile farmland under tons of concrete and asphalt? There were always other mountains, other forests, other farmlands. The forests would grow back, the mountains would miraculously heal themselves, and technology would replace the farms.

As you read this you may say, "But I'm an American. I'm a Gwinnett Countian. It can't happen here!"

It can. It has. It still is. Much of our fertile soil lies entombed beneath mammath airports or shopping centers, while rocky barren land remains unused. With careful planning, this situation could have been avoided. But who should do the planning? And how should it be done?

WHO SHOULD DO THE PLANNING?

There is a considerable conflict over who should be responsible for land use planning. Should it be done by ecologists, geologists, and hydrologists -- those with scientific understanding of the various aspects of the environment and how they interact? Or should it be done by economists and politicians -- those with understanding of the financial and social aspects of prescribing land use? Should it be done at the federal, state, county or local level? Or should it be left up to the developers and construction engineers?

Today, most states have land use laws and proposed long-range land use plans. They have turned over most of the responsibilities to cities and counties, which usually do their own planning within their boundaries. Some counties have joined forces with neighboring counties to coordinate planning over large areas.

Land use planning and zoning in Georgia are duties of municipalities and counties. In addition, the 18 Area Planning and Development Commissions of the state plan for development in their regions but have no powers to enforce their plans. The Atlanta Regional Commission is the one created for metropolitan Atlanta region.

The federal government has also established guidelines for land use planning in the form of the 1970 National Environmental Policy Act (NEPA). NEPA established a federal Council on Environmental Quality (CEQ) and required each federal agency to prepare an *environmental impact statement* in advance for every report or recommendation

for legislation or federal action relating to environmental quality. The purpose of the statement is to disclose the probable environmental consequences of a proposed action. Several states, including Georgia, now also require impact statements for certain development projects.

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WHAT IS LAND USE PLANNING?

Land use planning is a way of assuring the best potential use of land. Its purpose is, therefore, to enable people to get the maximum benefit from ecosystems without destroying them. Most planning that took place prior to the 1960s dealt not with the capabilities of a tract of land, but with its actual use.

A great number of geological and biological factors are now used in a systematic determination of the best potential use of a given land area. The table on the next page presents eleven of the most useful factors to be considered in making a land use decision. You can see that a whole series of studies is required to gain a total picture of the particular tract of land in question.

Major Factors in Land Use Planning

Environmental Factor	Data Needed
Aesthetics	Physical appearance from all accessible angles at ground level (especially from highways, residences, etc.)
Animal life	Type and abundance of most common soecies Environmental requirements of most common species
Current use	Type of uses within last 5 years (especially old landfill, pond or bog)
Flooding	Flood hazard based upon severest flood expected in 10, 25, 50 or 100 years Presence of known flood plain
Population density	Density of human population expected to be affected bu use
Resources	Availability of and accessibility to resources needed by specific use (especially sand, gravel, power, water)
Slope	Percent slope and topography Topography of adjacent area
Soil properties	Type and texture of horizons Depth of various horizons Bearing capacity Slippage Shrink-swell potential Erodibility Water absorption or drainage (permeability)
Surface water	Presence and sizes of streams, ponds or lakes, marshes or bogs
Bedrock	Type and distance below surface
Water table	Average depth Seasonal fluctuations

Most municipal and county planners, developers, potential homeowners, and construction engineers are not prepared for collecting such extensive information directly from the environment. They depend, instead, upon specialists in hydrology (science of water), geology, topography (study of land forms), and other fields to do the actual leg work. A soil survey book, such as the one compiled for Gwinnett County by the U. S. Department of Agriculture, contains much of the abiotic data needed for analyzing any tract of land in the survey area. Included in the book are detailed descriptions of soil types, limitations to their use, and a detailed map of soil types and slopes.

WHAT KIND OF SOIL?

The properties of the soil are probably the most important determiners of appropriate or inappropriate land use. Do you remember the proverb about the foolish man who built his house upon the sand? Soil can literally determine whether a building stands or falls.

Consider these situations and imagine how you would feel if they were true:

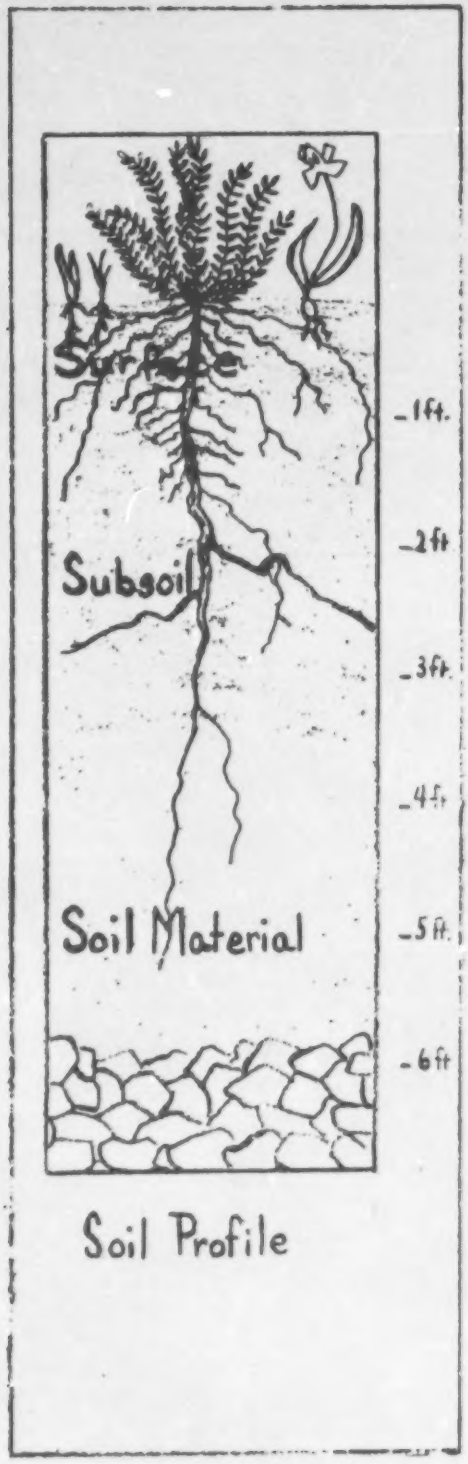
- *You move into your new house on Thursday, it rains on Saturday and you find your basement gameroom flooded with two feet of water on Sunday. Your carpet and new pool-table are ruined.*
- *You've lived in a new house for one year. After a week of heavy rains, your backyard both looks and smells like a cesspool.*
- *You wake up one morning to find that your expensive split-level home is really split.*
- *You come home from a family vacation trip to find that your house has moved down the block.*

If you think that these stories are exaggerated or too fantastic to be true, think again. Each of these very situations has happened, not to one person, but to thousands of homeowners throughout the country. They were caused by soil factors that should have been discovered before construction began. Examples of common soil textures in Gwinnett County are sandy loam, sandy clay loam, silty clay loam, silty clay, and sandy clay.

Houses built on a flood plain subject to periodic flooding.

Unstable soil with a high clay content in the upper 3 to 4 feet.

Soil with a high shrink-swell potential can crack foundations unless special construction methods are used.



Soil Profile

A *soil profile*, such as the simple one presented here, shows the layers or *horizons* of various depths in the soil. A soil horizon is a layer of soil, approximately parallel to the surface, with distinct characteristics that differ in one or more ways from its neighbors. Knowing what kinds of soils lie above and below each other in profile makes it possible for a soil scientist to predict the probabilities of *slippage* or land sliding.

Another bit of information needed by the soil scientist concerned with slippage is soil *permeability*, that is, the ability to allow the passage of water or air. Permeability is described according to the speed at which surface water passes through the soil.

In a situation where a loose, permeable horizon lies directly above an extremely impermeable one, the possibility of slippage is high. This is because the surface water rapidly seeps through the upper soil and then is trapped at the boundary of the impermeable horizon. The water cannot pass through the lower layer and therefore accumulates, spreading the horizons. This situation coupled with even a relatively gentle slope permits the entire upper horizon (and everything on it) to slide down the slope.

The *erodibility* of a soil (i.e. susceptibility to erosion), its *bearing capacity* (the load it can bear without excessive settling), and the ease with which it can be excavated are of special interest to developers and construction engineers. These properties are dependent on the size of soil particles and the consistency or "feel" of the soil.

Some soils, such as sticky clayey soils or hard, packed soils, are very costly to excavate. Other soils tend to shrink and swell alternately, depending upon the moisture content, or to settle rapidly and extensively. Abandoned landfills or recently filled ponds usually fall into the latter category. High shrink-swell or settling potentials call for special foundations in buildings to prevent walls cracking or foundations falling away.

Soil erosion is the most common land use problem. It can occur anywhere there is enough rain to cause runoff. The amount of erosion is determined by the kind of soil, the slope, the intensity of rainfall, and construction methods.

Erosion of land is much more severe when ground cover is removed prior to any type of construction. This is because the presence of ground cover reduces the impact of raindrops when they strike the surface and slows the movement of runoff water to allow more of it to be absorbed by the soil.

The eroded land is damaged through removal of its fertile topsoil, but there is another dimension to the erosion problem. The soil that is removed from one site is transferred to another where it is deposited as *sediment*. Sediment pollutes streams, lakes, and reservoirs and eventually raises their water levels as more and more material is laid down on the stream or lake beds. The eventual result is often flooding of areas downstream from the eroded site.

Careful attention to the characteristics of land areas and thoughtful cooperative planning by city or county officials, developers and landowners can prevent destruction of land. Coordination of needed or desired development projects with the most suitable sites can preserve the quality of the good land areas that remain.

Soil Moisture and Percolation Rate

Two Class Activities

I. Soil Moisture

The content of moisture in soil is an important abiotic factor to consider when planning any type of agricultural venture. The type of soil organisms that can live in an area is often controlled by the amount of humus in the soil, because humus tends to retain soil moisture. Water acts as a means of nutrient transport which is vital to plant growth.

The method used in this activity involves comparing the moist and dry weights of soil to determine the percentage of soil moisture.

Materials:

plastic drinking cups or beakers
soil (50-100 grams)
oven
balance

Procedure:

1) Weigh the beaker or cup and record its weight.
2) Add 50-100 grams soil to beaker and reweigh it. Record this weight.
3) Heat the beaker and soil in the oven at 100 C. for about 24 hours.
4) Weigh the beaker of dry soil and record the weight.
5) To calculate the percentage of moisture in the soil sample, use the following:

a. $$\frac{\text{weight of original soil (moist) and beaker} - \text{weight of dried soil and beaker}}{\text{weight of water in soil sample}}$$

b. $$\frac{\text{weight of dried soil and beaker} - \text{weight of beaker}}{\text{weight of dried soil}}$$

c. $$\frac{\text{weight of water in soil sample} \times 100}{\text{weight of dried soil}} = \%\text{ of moisture in sample}$$

Discussion Questions:

1) Why wasn't the weight of the moist soil used in the relationship 3 above?

2) Why is soil moisture an important abiotic factor in a community?

3) How do different types of soils compare in their soil moisture content?

II. Percolation Rate of Soil

Percolation rate is the measure of the speen of water infiltration into soil, or in other words, how fast water "soaks" into the ground. This activity can be performed on the school grounds.

Materials:

several cans of the same size with the ends removed

Procedure:

1) Select a site that is representative of your school grounds.

2) Place two cans in the ground for about the same distance (3 cm.). The cans should be about 50 cm. apart.

3) In one can pour a measured amount of water and record the time it takes for the water to enter the soil.

4) Repeat step 3 with the second can, except use muddy water. Record the results.

5) Your instructor may wish for you to repeat the procedure in other areas of the grounds or in other soil types.

6) If you can find worm burrows, it would be interesting to measure their effect on percolation rate.

Discussion Questions:

1) How did your results compare with the class's? What could account for the differences, if any?

2) What are some advantages of fast infiltration of water into the ground?

3) In what ways are earthworms beneficial to soil?

4) Is there any relationship between soil moisture content and percolation rate? Explain.

5) Why is percolation rate an important factor to consider when choosing a homesite?

6) Account for the difference in percolation rates between clean and muddy water.

PART IV: GETTING INTO THE ACT

A Land Use Problem

WASTE DISPOSAL AS A LAND USE PROBLEM

Adequate and appropriate disposal of wastes are serious problems of growing communities and Gwinnett County is no exception. There are two aspects of this problem: 1) removal of the waste from the individual household or business, and 2) treatment of the accumulated wastes from all sources in order to eliminate possible health hazards.

Wastes are often classified according to their sources. For example, *industrial wastes* are defined as any material discarded as an unusable by-product from an industrial operation. This includes scrap metals and plastics, rags, paper, numerous chemical pollutants of air and water, and a great variety of other materials. *Agricultural wastes* include animal manures, prunings from orchards and vineyards, and containers of pesticides and fertilizers. *Commercial wastes* are a great variety of materials from sources such as hotels, restaurants, hospitals, schools, service stations, and offices.

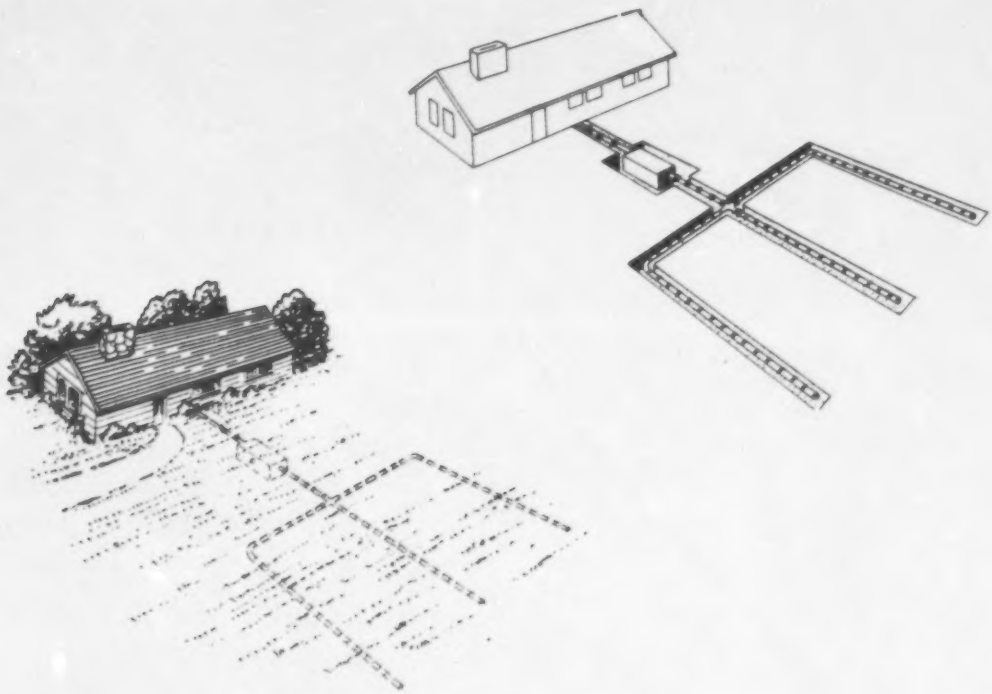
It is easy to see that waste disposal is an enormous problem, due both to the vast volume and diversity of wastes in our modern age. For this study, let us limit ourselves to another type of wastes that has not yet been discussed: *domestic or household wastes.*

Household wastes may, for the sake of convenience, be considered in two groups. *Solid wastes* are usually referred to as "garbage" or "trash." They include empty cans, bottles, plastic containers, paper, left-over food, and even old furniture. *Liquid or sewage wastes* are all the materials that leave the home through the drainpipes; that is, personal body wastes, dirty dishwater and water from the clothes washer.

Sewage Disposal

There are a number of things that can happen to liquid wastes after they disappear down the drain. They may flow into a private cess pool or oxidation pond, where particulate matter is allowed to settle out and bacteria can begin decomposing the organic materials. They may be pumped through miles of sewer lines into a sewage treatment plant where settling, filtration, the addition of chemicals, and bacterial action purify the water.

Sewage may also flow to an underground septic tank in the yard. The *effluent* or untreated water from which the solids have settled overflows from the tank into perforated pipes which disperse it over a large area. The entire septic system is covered with soil and planted with grass so that no part of it is visible.



Sewer lines to county sewage treatment plants are not available to many Gwinnett Countians. An example is seen in Snellville. It is the largest city in Georgia with no sewer system. Most people in the county rely upon private septic tanks for disposal of their liquid wastes, but not all land in the county is suitable for this use. In the Snellville-Mountain Park area, for example, there is an area where the soil is only about four feet deep with an underlying layer of rock. Septic tank capabilities in such an area are very limited. Proper planning would have revealed this fact and saved many people concern and a lot of frustration.

Septic tanks in the Liberty Heights area overflow into people's yards, creating an unpleasant odor and a definite health hazard. The Liberty Heights situation was caused by poor site selection also. The land is part of a flood plain and subject to frequent, extensive flooding. Septic tanks should never be used in such areas.

A properly installed and maintained septic system in an appropriate disposal site should function well for many years. If the soil is unsatisfactory, however, even the highest quality of construction and maintenance will not permit it to work properly.

When determining the suitability of a site for a septic tank, the following factors should be studied:

1. *Absorption capacity of the soil*

   The soil must be capable of absorbing and filtering the effluent.

2. *Absorption rate of the soil*

Absorption rate is determined by permeability of the soil. If the permeability is too low, effluent cannot be absorbed rapidly enough and will rise to the surface.

3. *Depth and profile of the soil*

A shallow layer of permeable soil overlying bedrock or a cemented soil will cause effluent to accumulate until it rises to the surface. At least four feet of soil is needed between the trench bottom and bedrock.

4. *Slope*

Slopes of more than 15 percent cause difficulty in controlling downhill flow of effluent. It may collect and reach the surface at the base.

5. *Drainage*

Well-drained soil is a necessity for septic tank use. Areas that are poorly drained, have high or seasonally high water tables, or are subject to periodic flooding should be strictly avoided. Wet soils cannot absorb as much effluent and overflowing may occur.

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Solid Waste Disposal

There are various methods that are used to dispose of solid wastes. Open dumping, burning or incineration, ocean disposal, composting, and sanitary landfills are the major practices used today.

Any site where garbage is left uncovered for more than one day is considered a dump. Mosquitoes, flies, rats and other vermin find that dumps are ideal habitats and breeding grounds. As such, dumps

are major health hazards. Periodic burning to cut down on vermin and increase space adds to air pollution. Many cities have for years had authorized dumping grounds, which are inexpensive and easy to maintain. In addition, hundreds of thousands of unauthorized dumps exist on private property and along roadsides.

Incineration might, at first glance, seem to be an excellent means of disposing of great quantities of wastes. It involves the closed burning of flammable wastes under controlled conditions. Air pollution control devices are, however, often inadequate and incineration merely becomes an exchange of one sort of pollution for another. Incinerators are also costly to install and maintain.

Many coastal communities solve their solid waste disposal problem by loading the material onto barges and dumping it into the oceans. In some areas, this has become a serious problem in the form of water pollution and degradation of beach properties.

Composting is a method of waste disposal that makes use of the natural decomposing activities of some *aerobic bacteria*. These are bacteria of the soil which, in the presence of oxygen, break down organic wastes for food. The major disadvantages of composting is that it is expensive on a large scale since it involves separation of inorganic wastes such as metal, glass and plastics from the organic wastes. Many landowners maintain their own compost heaps, however, and use the decayed material as mulch for flower gardens.

Sanitary landfills are considered by experts to be the most desirable form of solid waste disposal. When properly run, a landfill produces no foul odors and there is a minimal danger of pollution.

Sanitary landfill operation is based upon the use of *anaerobic soil bacteria* to decompose the organic wastes. It functions along the same principles as composting, except that the bacteria involved are active in the absence of oxygen. Wastes are crushed, dumped into trenches or pits and covered with earth daily. The cover material is then firmly compacted to remove air from the soil and to prevent the entrance of more air. A landfill may be operated for several years. When completed it is seeded with vegetation and allowed to settle. Eventually, the land may be used for recreation purposes or construction. It is important, however, that care be taken in the design and construction of any building placed on the site of a former sanitary landfill.

There is a major problem with solid waste disposal in Gwinnett County. With no county-run garbage pick-up or landfill the people of the county must either pay a private company to pick-up and dispose of their garbage, carry their own garbage to one of the county's three private landfills and pay them for its disposal, or carry their garbage off and dump it on a back road somewhere. A short drive over some of Gwinnett's back roads easily reveals which of the alternatives many citizens prefer.

Dumps for all household garbage and industrial wastes are not illegal in Georgia. Sanitary landfills are the accepted legal form of solid

waste disposal. Planning for their location is a task that requires a careful survey of sites.

The factors that should be considered when selecting a site for a sanitary landfill are:

1. *Height of water table*

   If the water table is too high or the area is flooded the ground water may become contaminated.

2. *Slope*

   Steep slopes are subject to erosion since runoff water is more difficult to control. More grading is necessary for access roads to landfills on steep soils.

3. *Ease of excavation*

   This factor is especially important since, in a properly run sanitary landfill, wastes must be covered daily. Fine-textured soils with a high clay content are usually poor sites because of the difficulty they pose to vehicles when wet.

4. *Permeability of the soil*

   Soil should have low permeability to prevent water movement from the landfill into underlying layers where it may pollute ground water.

5. *Cover material*

   The material used to cover the wastes must be easy to dig. move, spread and compact during both wet and dry periods. It should also be suitable for revegetation when the landfill can no longer be used.

Recycling

Much of the problem of waste disposal as it exists today is related to our "throw-away" society. Many items that we use are intended to be used once or a few times and discarded. Consider such things as paper napkins, non-returnable soft-drink bottles, and plastic egg cartons.

The ideal solution to the waste disposal problem is to re-use materials whenever possible. Recycling of certain products, such as paper, glass, and metal, would cut down tremendously upon the volume of material that must be disposed of. Many communities have initiated recycling campaigns that have been continuing successfully for several years. Others have abandoned the idea for a number of reasons -- one of which is the problem of separation and collection of the recyclable materials.

The Resource Recovery Act of 1970 stimulated many companies to design systems of waste handling and separating designed to service groups of cities. Recycling, therefore, is a feasible solution to at least some of the problems of waste disposal for communities.

For too long we have hidden our wastes along little-used roadsides or have turned it over to the trash collectors and promptly forgotten about it. It is time to realize that our garbage does not just disappear. However, with *careful consideration of alternatives and proper planning*, waste disposal as a problem can be greatly reduced, if not eliminated.

Check Your Understanding

1. What are several sources of solid wastes and how are they disposed of in your community?

2. Of the above, which seems to present the most disposal problems? Explain.

3. What would be the best type of liquid disposal system for
   a. a city
   b. a rural community
   c. a lakeside resort used only in the summer?

4. When determining the suitability of a site for a septic tank, what factors should be studied?

5. What is(are) the difference(s) between a dump and a sanitary landfill?

6. What factors should be considered when selecting a sanitary landfill site? Explain.

7. What are the advantages and disadvantages of recycling solid wastes?

8. How is the problem of solid waste handled in your community? Who does the planning? Who does the actual work?

Land use planning in Georgia-and throughout the nation-has become a necessity. In the past several decades we have increased our population and used up our natural resources at a rate so alarming that unless we plan now the way we wish to use our land in the future, we shall find ourselves with little that remains usable at all.

. . . it is the people, acting through their official representatives, who must make the final important decisions determining the future character of the state.

Hopefully, the Georgia of the future will be guided by a state land use plan outlining procedures by which each area can manage its particular resources for the highest use. Some land will be slated for industrial development, some for offices, some for homes and home-related services, and some for recreation. And, some will be left untouched as greenbelts, buffer zones, wildlife preserves, wilderness, or primitive parkland. The questions of who decides the "highest use" of each land parcel, and how, are being answered now as the state government presses ahead with hearings on land use legislation.

One thing is certain: the future of the human race depends on its ability to plan. Georgia's success in providing for the quality of life of its citizens hinges on the same ability.

James D. Landrum
President, Georgia Conservancy
Georgia Conservancy Magazine
Fall, 1972

Conclusion

Ecology is not a pure science, but an applied one. Knowledge obtained through its pursuit is used to develop practical solutions to serious environmental problems. Ecologists and other scientists are not the only people who can make use of ecological data, however. We, as citizens, must also shoulder some of the responsibility for environmental decision-making. After all, this is our world to live in and, if it is destroyed or fouled to the point of uselessness, we will suffer for it. Those who must bear the consequences of an action should and must share in determining what that action should be.

The resources that are available to us are finite; they can give out. There is only a certain amount of air, water, and land to be shared by all the living organisms on this planet. Once it is gone or rendered unusable, there is no replacement. An appreciation of the interdependence among all life forms, as well as between the biotic and abiotic components of environment, is essential to a good life in Gwinnett and a responsible world citizenship. Knowledge is not enough. The responsibility for decisive action belongs to all of us and the time for action is now.

Everything that lives,
lives not alone,
nor for itself.
BLAKE

"I just built a $50,000 home around the corner. I shudder to think what this will do to my property values."

* * *

"Who ever heard of putting a landfill next to a public school? Kids have enough distractions. Why add noisy bulldozers and trucks to the area to distract them more."

* * *

"My apartment is just down the road from there. How would you like to look out your window at piles of garbage every day?"

* * *

"Another landfill is just what we need. I'm tired of having to drive twelve miles to the Arnold Landfill every three days to dump my trash."

* * *

"Well, I'm just not sure what this will do to the water and the soil in that area. I would like to check over the drainage maps first and maybe check into the soil type."

* * *

"Good news. A new landfill. Now maybe folks will stop dumping their garbage on my property!"

* * *

"At first I was really against having a dump over in this area. But I read in the paper that a sanitary landfill isn't the same as a dump. I guess if Sanoclean runs it right, ir probably would be okay."

* * *

"I'm not real happy about it, but at the price we have to pay for progress."

* * *

These remarks give you some idea of the controversy that has arisen over a proposal by two landowners to obtain special exception zoning and place a landfill operation on their land. The location is real. The situation is quite possible. The problem is a real one in any growing community. *However, all of the names and the case itself are fictional.* The case is presented to give you an opportunity to think

through the alternatives, weigh the strong points against the weak points and make a decision about what you would say and do in a hearing like this.

You will play the role of an interested citizen in this simulation of a landfill zoning case. In this role you will contribute to a land use decision in Gwinnett County.

The site under consideration is located approximately two miles from Berkmar High School on the south side of Cruse Road. It is bounded on the east by Sweetwater Creek and on the west by land on which the new high school is being built.

Members of the class will act out the roles of the people involved in deciding whether this piece of land should be used as a sanitary landfill. Use the knowledge that you have gained from environmental studies in science and social studies. But also try to effectively play the role you have been given. The procedures that you will follow are similar to those that would be followed in a real "special exception" zoning case.

The Case

On Cruse Road just about two miles from Berkmar High School there is a 35.6 acre plot of undeveloped land located next to the land on which the new high school is being built. (See large map on wall)

The joint owners of this land, Howard and Altman, wish to lease it to the Sanoclean Landfill Corporation of Gainesville. Presently the land is zoned M-1 or light industrial zone. The owners have applied to the Zoning Board of Appeals for a "special exception" zoning which would allow them to have the land used as a sanitary landfill.

Following the application for special exception zoning, a sign was posted on the property announcing the application and the fact that a public hearing would be held in two weeks. The application was also advertised in the Gwinnett Home Weekly. The hearing will be held tomorrow before the Zoning Board of Appeals.

A number of residents of the Cruse Road-Pleasant Hill area who are aware of the proposed zoning change have organized to oppose the change. School board members are concerned about the landfill's location near the new high school. Some local citizens are concerned about the general effects on the water and soil in the surrounding drainage area.

On the other hand, county leaders concerned about the waste disposal problems in the area are interested in having another landfill to receive the trash and garbage of this populated section of the county.

The owners contend that the Sanoclean Corporation will run a completely sanitary landfill and that its operation will not in any way jeopardize the beauty and healthful environment of the Cruse Road neighborhood. They claim that the landfill will effectively serve the highly populated area north of Cruse Road and will therefore be a benefit to the community.

Many arguments,pro and con,have emerged, and a large turnout at the public hearing in the county courthouse is expected.

The Simulation

"Zone of Contention" is designed for 3 - 4 class periods. It takes place in three sequential stages. There is a short initial meeting of the Zoning Board of Appeals followed by a period during which special-interest groups meet to study the situation. The final stage consists of a second meeting of the Zoning Board of Appeals. Most of the debate over the issue takes place during this third stage. Finally, the Zoning Board makes its decision.

Each member of the class has a card describing the role he or she is to play during the game. This card will give you information about occupation and interests as well as a statement concerning your opinions. You should make every effort to stay "in character" throughout the play, responding to events and the other characters in the way your character would most likely respond. You should, however, listen carefully to arguments presented by both sides in the controversy. READ YOUR ROLE CARD CAREFULLY.

Each person will be a member of an interest group. There are three interest groups which will meet and gather information in preparation for the final hearing. When you read over your role card you will see that your interest group is listed at the bottom.

Some of the questions that should be considered in each group are:

1. Do we want or need another landfill in Gwinnett County?
2. Do we want the landfill located at this site?
3. Is this site appropriate for use as a sanitary landfill?
4. What would be the consequences -- both environmentally and economically -- of locating a landfill on this property?

Consider each of the questions from the viewpoints of the role which you are playing. Then review the full list of characters involved to get an idea of other people's interests.

The three stages of the simulation are described below:

Stage I

A. Zoning Board of Appeals Chairman calls the meeting to order and gives a brief statement describing the reason for the hearing.

B. The land-owners and representative of the landfill corporation then make initial statements.

C. Two home-owners may present counter arguments.

D. The Chairman of The Zoning Board suggests that the crowd of participants take time to study the situation in depth.

Stage II

Special interest groups meet to research the situation in more depth and to prepare arguments for the final hearing. The following chart indicates the groups that meet together and gives some suggestions to guide discussions. You do not have to limit yourselves to the suggestions given nor do you have to reach any kind of agreement as a group. The purpose of this stage is to allow everyone to become familiar with the situation and to "get into character."

Group I: County Officials

Bell	Merritt
Blake	Miller
Fountain	Morgan
Harper	Phillips
Hayes	Stanley
Livingston	Widener

Group II: Pro-landfill

Altman	Janecki
Calhoun	Sanders
Howard	Wiley

Group III: Con

Allen	Metcalf
Bernstein	Michaels
Burton	Monroe
Caproni	Morrison
Evans	Victor

Stage III

The Zoning Board reconvenes. Board members may ask questions or call for expert opinions from anyone in the audience. Any citizen may also raise questions or express an opinion before the Board. Remember to "stay in character." After the hearing, the Zoning Board of Appeals will vote and report the decision to the group.

Blake - Member of Zoning Board of Appeals

You are a member of the Zoning Board of Appeals. You were appointed by the County Commissioners to serve on this important board which considers all request for rezoning or"special exception" zoning in public hearings. In this special exception hearing, your Board's decision is final.

You were a farmer for a number of years, and then five years ago you sold your farm to go into the farm machinery and large equipment business. Generally you are concerned about the neglect of the soil and consider the county to have "overdeveloped" into residential sub-divisions and industries. On the other hand the sale of bulldozers and other large equipment used in development can boost your business which had been in a decline in the current recession year.

Morgan - Member of Zoning Board of Appeals

You are a member of the Zoning Board of Appeals. You were appointed by the County Commissioners to serve on this important board which considers all request for rezoning or "special exception" zoning in public hearings. In this special exception hearing, your Board's decision is final.

You are a lawyer in a family law firm. You are known throughout the county as a leader in environmental causes. You are a member of the National Wildlife Federation and the Sierra Club and are active in the Georgia Conservancy. You are an outspoken advocate of strong enforcement of the ordinance against dumping.

Phillips - Member of Zoning Board of Appeals

You are a member of the Zoning Board of Appeals. You were appointed by the County Commissioners to serve on this important board which considers all request for rezoning or "special exception" zoning in public hearings. In this special exception hearing, your Board's decision is final.

You are an established building contractor who has built many of the larger industrial buildings and business offices in the county in the last ten years. You openly encourage more development for its general economic benefits to the county. You feel that an expansion of industrial and business growth will create more jobs and more income for the county.

Harper - Member of Zoning Board of Appeals

You are a member of the Zoning Board of Appeals. You were appointed by the County Commissioners to serve on this important board which considers all request for rezoning or "special exception" zoning in public hearings. In this special exception hearing, your Board's decision is final.

You are the head of a family plumbing firm. Nearly forty years ago your grandfather started the plumbing business in the county and your family has resided in Gwinnett ever since. You are convinced that growth has brought great progress to the county. Currently you are concerned about the problems of garbage and trash disposal. Disposing of discarded plumbing fixtures, old pipes and such junk has been inconvenient and rather costly since the nearest landfill is privately run and 23 miles from your business.

Miller - Member of Zoning Board of Appeals

You are a member of the Zoning Board of Appeals. You were appointed by the County Commissioners to serve on this important board which considers all request for rezoning or "special exception" zoning in public hearings. In this special exception hearing, your Board's decision is final.

You own a large department store in a large shopping center in the county. Generally you are in favor of rezoning land in and near residential areas to provide the convenience of business or institutional development close to each large subdivision. Recently you have been quite concerned about the inadequacy of garbage and trash collection in the shopping center. You have complained to the Board of Commissioners that the garbage collectors franchised by the county tend to skip the dumpsters in the shopping center on some collection days. You have been encouraging the commissioners to consider some new system of collection.

Fountain - Chairman of Board of Commissioners

You are now serving in your final year as Commission Chairman, a full-time elected position for which you plan to run again. It is, therefore, very important for you to be familiar with the likes and dislikes of the voters. You believe that growth means progress and have encouraged expansion of the business and industry community in the county.

You are joint-owner in a successful heating and air-conditioning firm, now run by your partner. You and your family will not be personally affected by a new landfill, since you live in Lawrenceville. However, you do often hear complaints from Gwinnett Countians about the current sanitation system.

Merritt - County Health Official

You have held your position as Health Inspector for nearly twenty years. You plan to retire in two more years. You are very outspoken in your opinion that Gwinnett started going "downhill" in the 1960's and the descent has been growing more rapid during every year since. You have kept yourself knowledgeable about improvements in public health through the years and are a conscientious citizen in your own way. Having had a considerable amount of experience with the actual operation of landfills, you are concerned with the possible health hazards that could result from locating a landfill so near a highly-populated area.

Bell - Administrative Assistant

You are the newly appointed administrative assistant to the Board of County Commissioners. You have had special training in public administration and five years experience in administration in another Georgia county.

Your job is to take care of the day-to-day tasks of running the county government. The commissioners depend on you to get the facts on any issue that arises and help provide them with details on various county government operations. Because recent press coverage has highlighted the problem of dumping in the county, the Chairman of the Board of Commissioners has asked you to look into the county's waste disposal program and present your evaluation of it.

Altman - Land Owner

You and your business associate, Howard, purchased the Cruse Road property eight years ago when this area was almost completely undeveloped. You thought the land might be a good investment. The land was not considered good land for residential development, but it was relatively inexpensive and located in a section of the county that was obviously increasing in population.

You were contacted by the Sanoclean Corporation last year and offered a good annual income from leasing the land to run a landfill on it. Last month you and Howard met with corporation officials to work out an agreement. Now obtaining permission from the county Zoning Board is an important step in completing the agreement.

You and Howard have invested in other land in Gwinnett and Rockdale Counties. You live in Gwinnett and run a wholesale paper supplies company in Norcross.

Howard - Land Owner

You and your business associate, Altman, purchased the land on Cruse Road eight years ago for an investment. Because you live in Atlanta, Altman has overseen land investments in Gwinnett.

You had previously encouraged Altman to put the land up for sale, but when he called you last month about the Sanoclean leasing deal, you considered that this land might improve in value in the long run. You are convinced that developing the property as a landfill will improve its surface features and eventually after it is all filled in it will be more valuable.

Bernstein - Apartment Owner

You own the apartment complex across the road from the proposed landfill site. You recognize the fact that a landfill is needed in the area near Cruse Road, but object to its location so near to your complex. You fear that property will be devalued and that the area might be less desirable to potential tenants. You attempted and failed to purchase the property in question last year, planning to put up a new apartment complex there.

Burton - Environmental Protection Division Representative

You live in a subdivision north of the Cruse Road area. You work with the Environmental Protection Division of the Department of Agriculture in Atlanta. You have been asked to appear before the board in the interest of a group of citizens who are concerned by the ever-increasing development in the Cruse Road area. You hold a Ph.D. degree in Environmental Science from the University of California at Berkeley and did your undergraduate work in Zoology at the University of Georgia.

Monroe - Farmer, Member of Board of Commissioners

You are 52 years old and have lived in Gwinnett County all your life. You have three married daughters and four grandchildren, all of whom live in the county. You own a moderate-sized farm near Snellville, which is operated by one of your sons-in-law. You consider yourself semi-retired, but serve as a member of the Board of Commissioners because you are actively concerned about the county.

You have witnessed the local population explosion and feel that Gwinnett does not need any more people or industry. You have been distressed by the acres and acres of fertile farmland and forest that have been destroyed for development in the name of progress. For this reason, you are intensely interested in any land use decisions.

Evans - Eastern Electric Plant manager, Member Board of Commissioners

You moved to Gwinnett County from Ohio only five years ago to become plant manager at Eastern Electric. You are rather young to hold such a position; however, you are highly intelligent and ambitious person. You became actively involved in the community almost immediately upon your arrival, bringing to your civic activities the same enthusiasm and vitality that you show on the job. You are presently a member of the Board of Commissioners and plan to run against Fountain in the upcoming race for Commission Chairman.

You are for adopting a "no-growth" policy in Gwinnett County and feel that the county should provide sanitation service for the citizens.

Livingston - Agent of Resource Conservation and Development Service

You are 28 years old and a recent addition to the staff of the Gwinnett County Resource Conservation and Development Service, a division of the U.S. Soil Conservation Service. You received a master's degree in Agronomy from North Carolina State University with emphasis on soil conservation. You worked for three years as an assistant conservationist in Raleigh before being transferred to Gwinnett. You consider that it is part of your job to be interested in any actions taken in the county which could have negative environmental effects.

Stanley: State Soil Conservationist

You are a State Soil Conservationist for Georgia, with an office in Athens. You have been asked by Livingston to study the situation in question, since you have more experience in the area. You have lived in the North Georgia area for nearly all of your life and are familiar with its environmental peculiarities.

Hayes - Professional Planner

You are a professional planner who works for the Planning and Zoning Division of the county government. You are a trained and experienced community planner who left a city planning job to take the job in Gwinnett in 1970 when the major land use plan for the county was developed.

You are generally opposed to mixing residential, commercial and institutional zoning in patchwork patterns and strive to encourage the development of protected strips which protect property values and economic and social development.

Widener - Professional Planner

You are a professional planner who works for the Planning and Zoning Division of the county government. You joined the Gwinnett planning staff after completion of training at a large southeastern university two years ago.

Generally you favor cluster zoning in the areas not yet developed. Also you encourage the commissioners to consider setting aside more park area and open land as the county develops. You are currently involved in preparing a report for the county administrator summarizing solid waste disposal problems in the county and suggesting possible alternatives for county action.

Metcalf - ARC Representative

You are a member of the professional staff of the Atlanta Regional Commission. Trained as a geologist, you were hired on the ARC staff two years ago to aid in the preparation of information summaries and maps of the land characteristics of the metro region. You recently completed studies of drainage, rock and soil characteristics of the area.

Organized homeowners who want to block the proposed landfill location have called you to come to the hearing and testify about the potential negative impact the landfill will have on the area.

Morrison - School Board President

You are the current president of the county Board of Education. Recently while checking over progress on the construction of the new high school on Cruse Road you noticed the sign on the adjacent property advertising the hearing for special exception zoning. You are very concerned that the proposed development of that land is for a landfill. Although this proximity of a landfill will have its advantages for easy waste disposal by the nearby high schools, you are concerned about the traffic hazards and the possibility that the landfill will not be properly operated so as to keep the area sanitary and healthy. Many school board members have objected to the location of the landfill in this school zone, and you plan to attend the hearing to listen and offer some remarks.

Michaels: Home Owner

You are a private home owner in a subdivision located near the proposed landfill off Cruse Road. You have organized other home owners to fight against the special exception request. You fear that garbage trucks and commercial trucks driving in and out of the landfill will cause a real traffic hazard for both children and adults. Also, you are concerned that trash and garbage from these vehicles may be blown off or drop off onto the surrounding property of the area making the whole neighborhood unsightly.

Caproni - Home Owner

You are a new home owner who lives on Pleasant Hill Road not far from the intersection with Cruse Road. You are greatly concerned about the effect the landfill may have on the value of your property and that of your neighbors. You have joined with Michaels in organizing local residents to fight against the location of a landfill in the area. You plan to attend the hearing to speak against the landfill.

Janecki - Representative of Sanoclean Landfill Corporation

You are 55 years old, married with two adult sons. You have held a variety of occupations in your life, but worked as a truck driver for 15 years. Through a combination of thrift and wise investments, you were able to form Sanoclean in 1968. You currently operate four landfills in surrounding counties. You personally hire and train your operators. The Cruse Road property with its gullies and pits appears to be a good location for another fill.

Calhoun - Attorney for Land-owners

You are an Atlanta lawyer hired to handle this case for the land-owner who wishes to have his property developed as a commercial landfill. You have looked into legal aspects of this case and found that the zoning regulations of the county allow a proposal for landfill to be considered in any type of zoning except flood hazard zoning. You have advised your client to go before the Zoning Board of Appeals and request special exception zoning of his M-1 zoned land.

You plan to attend the hearing to argue that this procedure is entirely acceptable under the law. You also hope to convince any objectors that the commercial landfill will be a sanitary operation run according to state legal standards.

Wiley - Construction Engineer

You are 23 years old and have recently received a degree in Construction Engineering from Georgia Tech. You were a senior at Berkmar during the first year of its operation and feel loyalty to the school. You fear that the locality might be degraded by the location of a landfill there.

Your apartment faces Cruse Road and directly overlooks the proposed site. You are concerned about the possibility of foul odors, loud noises, and destruction of the beauty of your view. You have however, explored the site and feel that it would probably not be useful for any other kind of development. It is also possible that, when the landfill is completed, the condition of the land will be improved. You want to know more about the situation before formulating an opinion.

Sanders - Realtor

You are a realtor, whose financial success is more or less dependent upon population growth and property values. You moved to Gwinnett twelve years ago from Atlanta, having foreseen the suburban migration as an inevitable result of ever-increasing crowding in Georgia's capital.

You believe that the proposed landfill would have little effect on property values if operated properly. Sanoclean plans to leave a stand of trees adjacent to the road, shielding the operation from view. Daily covering of the trash should effectively prevent foul odors.

You believe that most home owners will be glad to have a landfill so conveniently located.

Victor - Apartment Dweller

You are 32 years old, married, with twin 8-year-old sons. You are an accountant for a local business firm and have lived in Gwinnett for six years. You represent a group of concerned residents from the apartment complex across the road from the proposed site. You and your neighbors are concerned about the potential dangers that might exist for curious kids who habitually play together in that currently vacant lot. You also feel that development has already destroyed too much of the scenic natural areas of Georgia.

Allen - Insurance Salesperson, Member Board of Commissioners

You are 37 years old and parent of a 9-year-old son and a 13-year-old daughter. You own a $40,000 home near the site under consideration. It is very likely that your daughter will attend the new school when it is built. You sell all types of insurance, but have done very well in recent years by concentrating your efforts in the area of property insurance. You are, of course, interested and concerned about the effects that a landfill would have on property values, especially since your company insures the apartment complex just across the road from the proposed site.